ACCIDENTS IN MINES.*

(*Continued from page 244.*)

VI.

Coal Dust.

The results obtained showed that in a gallery or mine-working of an area not very dissimilar to that in which the accidents just referred to occurred, the flame or heated gases from 1½ pound and 2 pound charges, fired under conditions favorable to the complete projection of the flame in the direction of the discharge, only reaches occasionally, and to a very limited extent, to a distance of 20 feet. No doubt a powerful air current in a mine, passing in the direction in which the shot is fired, must have a tendency to aid the extension of the flame to a greater distance, but the difference between 20 feet and 100 feet is far too great to be only ascribable to the effect of on air-current in elongating the flame. As the first of the loop-holes in the walls above referred to was 18 feet from the shot, it could hardly affect the distance to which the flame was found to reach; indeed in subsequent experiments the loop-holes were closed up without affecting the results.

It was thought that some experiments in subterranean passages of much smaller dimensions (military countermines) might give instructive results. A so-called "envelope gallery" was therefore first selected for the purpose. This gallery was 5 feet 9 inches high to the crown of the arch, 4 feet 9 inches to the springing of the arch, and only 2 feet wide. The part selected for the placing of the gun and the target was straight, but the portion immediately beyond and in front was curved. In rear of the gun the gallery was quite open to a considerable distance. Charges of 1½ pound untamped were fired, and a frame target the width of the gallery and 4 feet 6 inches high, constructed so as to give fifteen points to the attachment of gun-cotton tufts, was placed at gradually decreasing distances from the gun, commencing at 20 feet. Even at a distance of only 14 feet from the charge, none of the gun-cotton tufts were inflamed, but the target was blown forward about 12 feet and partly broken. It was evident that the fact of the gallery being open at the *rear* of the charge greatly reduced the tendency to the projection of flame to any distance in the direction of the explosion. The resistance opposed to the movement of the air by the curvature of this narrow gallery, a short distance in front of the seat of the experiments, may have also contributed to diminish the distance to which the flame or highly heated gases would extend. When the experiments were continued in another gallery, of the same dimensions, but straight, and terminating in a head, like a drift in a mine, the cannon being placed close up to the face, several of the tufts of gun-cotton were inflamed at a distance of 27 feet; one was inflamed when the target was 30 feet off, and one also at a distance of 32 feet, but none were ignited at a distance of 35 feet from the charges. Here, then in a long gallery narrow in proportion to its height, but in all other respects representing a drift way in a mine, the distance to which the flame of a blown-out shot of 1½ pound of powder extended, was less than 35 feet, and therefore considerably less than one-half the distance from the seat of the blown-out shot of one pound of powder where the men were burned, in both directions in the cross workings, in the accident above cited.

The influence of coal dust in increasing the distance to which a flame from a blown-out shot will extend in mine workings is therefore conclusively demonstrated by a comparison of the effects of the accidents referred to by Mr. Hall with the foregoing experimental data. On the other hand the circumstance noted by Mr. Hall, that no signs of turning on the props of the mine were visible at greater distances than a yard or two beyond the spots where the men were waiting, although there were open workings in both directions for some considerable distance, and although the flame was sufficiently extensive there to injure the men severely, seemed to indicate that the particular coal dust existing in these workings had not the power, or was not raised in sufficient abundance, to carry on the flame to a great distance from the source of fire. Had there been any gas in the air of the mine the flame would doubtless have extended much farther, and perhaps throughout the adjacent workings. The amount of dust raised by the blown-out shots may, however, have been less considerable than in other similar occurrences, and the dust itself may not have been so highly inflammable, or it may have been damp, or otherwise not of so suitable a character for carrying on flame, as the dust existing in other mines where undoubtedly it has played an important part in enhancing the magnitude of explosions.

Some experiments were made in the "Caponier" and in the narrower mine-galleries at Chatham, with the object of comparing the distance to which the flame from a blown-out shot would extend in the absence of coal dust and with the dust suspended in the air *in the complete absence of fire-damp*. It was not possible to render the conditions of the experiments nearly as favorable to the propagation of flame by coal dust, to a distance from its point of origin, as must generally be the case in mines, because on the one hand it was difficult to provide in the galleries the conditions essential to the production of a heavily dust-laden atmosphere, while on the other hand the extension of the flame received comparatively little aid from the very moderate air-currents which in some cases traversed the galleries in the same direction as the flame of the shot, and was even in some degree impeded, in several instances, by the course of the natural air-current being towards the shot. The results appeared, however, of value at the time as demonstrating the power of coal-dust to effect a very considerable extension of the flame from a blown-out shot in the complete absence of fire damp and in galleries of dimensions similar to those of mine-ways and workings, and also as indicating that, under these conditions, the atmosphere of a mine must be very thickly laden with coal dust, at the moment that the flame is projected into it, for the latter to be propagated to any very great distance. While the flame from a blown-out shot, consisting of 1½ pound or 2 pound of powder, either tamped with clay or untamped, did not extend beyond 20 feet, and not always as far, in the very capacious "Caponier" gallery, the suspension of a little coal dust in the air caused the flame from a 1½ pound charge to extend to 37 feet, and that, when the dust was somewhat more copiously suspended in the air, the flame passed beyond that part of the gallery where it curved at right angles, extending to a maximum distance of 45 feet.

In the comparative experiments made in the long and much narrower (countermine-) galleries, which more closely approximated in character to coal-mine workings, the effect of coal dust in extending the flame from a blown-shot was much more marked. The maximum distances reached by the flame from 1½ pounds of powder in the absence of coal dust, and with the natural air current travelling away from the shot were between 30 and 35 feet; while, with some coal dust (but no large quantity) suspended in the air, the flame extended to a distance of 83 feet in the upper part of the gallery, where the dust was most abundant, and to 53 feet, near the floor, where there was very little dust. This result was obtained when the natural air-current was away from the shot, its velocity being 131 feet per minute. With the current travelling *towards* the shot, at a rate of 52 feet per minute, the flame extended to a maximum distance of only 66 feet (in the top of the gallery), the air being warm and dry at the time, while with a current of 94 feet velocity travelling towards the shot, and the air and sparsely suspended coal dust being both damp, the flame did not extend beyond 26 feet.

Some interesting results were obtained in a long (countermine) gallery open at both ends, and intersected at right angles by another similar gallery at a distance of 70 feet in front of the shot-hole(or gun) Charges of 3 pounds of powder, untamped, were fired, and coal dust was blown into the air about 50 feet in the rear of the gun, the natural current travelling at the time along the branch of the cross gallery to the left of the shot. The quantity of suspended coal dust was not large in any of the experiments; in the first it was very small, and the flame only extended up to 50 feet, in the top of the gallery; in the two following experiments the quantity was slightly increased, and the flame extended up to the cross gallery, and to a distance of 6 feet along the top of the left branch in the direction of the current. In the third and fourth experiments, the amount suspended being still somewhat increased in each case, the flame was projected beyond the extremity of the gallery (81 feet) into the open air; in the third experiment it also extended 12 feet along the top of the left branch of the cross gallery, and in the fourth it reached to a distance of 18 feet in this direction, and perhaps further (as no gun-cotton tufts had been placed beyond that distance); it also extended 3 feet along the top of the right branch of the cross gallery.

These experiments, which were carried out between January, 1882, and August, 1883, afforded conclusive proof that in galleries or air ways approximating in their nature to those existing in coal mines, coal dust, even when sparsely suspended in the air, provided both are in a fairly dry condition, will feed the flame projected by a blown-out shot so as to carry it, on to a comparatively considerable distance, and the particular results last referred to demonstrated that, even with the limited dust-supply which it was possible to suspend in the air, the flame not only extended to a distance of over 80 feet from the seat of the blown-out shot (being projected into the open air beyond), but that it also extended into a cross-working, and even in a direction opposed to the natural air-current at the time.

These last results approached in magnitude and decisiveness those which have been furnished by a very important series of experiments, made between July and December, 1884, by the Prussian Fire-damp Commission at the suggestion of one of its member, Mr. Hilt, of Aachen.* The existing differences of opinon regarding the part taken by coal dust in colliery explosions, and more particularly the peculiar views on the subject enunciated by MM. Mallord and Le Chatelier in the Report of the French Fire-damp Commission, to which we shall presently refer, led Mr. Hilt, in a memorial addressed to his Commission, to urge upon that body, as its

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc," 1886.

*Certain of these experiments were witnessed by one of Your Majesty's Commissioners.

duty to investigate the question by experiments on a large scale. On the recommendation of the Commission the experiments were sanctioned by the Minister of Public Works. The locality selected for them was the pit-heap of the Wilhelm Pits of the fiscal coal mine König, in the Saarbrücken District, there being a powerful blower at those pits at a depth of 363 feet, which could be easily piped to the surface, and which has for the last two years yielded gas at the rate of 0.9 cubic foot per minute. The general arrangement and conduct of the experiments were entrusted to Mr. Hilt, and their execution was in the hands of Mine Inspector Margraf. The gas was collected in a holder of 176 cubic feet capacity, and was transferred thence to the apparatus as required.

The experiments were conducted in an elliptical main gallery 167 feet long, closed at one end, with a branch gallery at right angles to it, 33 feet long, at a distance of 74 feet from its open extremity, and having a door fitted with safety valves, so that it could be closed. The galleries are constructed of elliptical rings of double T-iron, lined with well planed 6-inch deal planks, fitted closely together by being grooved and feather jointed. The major axis of the gallery is vertical, being about 5 feet 7 inches, and the minor axis is 3 feet 11 inches. One end of the main gallery enters, to a depth of about 3 feet 10 inches, a block of brickwork 13 feet high, 9 feet 8 inches wide, and 12 feet 4 inches deep. Seven cast-iron cannon (one central and six circumferential) are built into this block, with their muzzles flush with its inner face; the diameters of their bores correspond to the ordinary diameter of shot holes (the central cannon being 1.57 inch in diameter, and 37 inches long, while the others are 1.38 inch in diameter and 31.5 inches long). The axes of the two upper and two lower cannon are so placed that they form the angles of a four-sided regular prism, the apex of which is situated at a distance of 16.4 feet from the face of the brickwork, in the axis of the main gallery. The prolongations of the axes of the three other cannon meet at the same point. Behind the breech of each cannon buffers are fixed, consisting of alternate layers of soft wood and vulcanized india-rubber, to protect the brickwork, and the latter is bound together by iron stays. Nearly 2 cwt. of powder have altogether been fired from the cannon without affecting their position or the stability of the brickwork. The main and branch galleries are so imbedded in the pit-heap that on one side the rubbish reaches to the top, and on the other to about three-fourths of their height. The exposed part of this side is provided with thirty-two square windows in the main gallery and three in the branch gallery, about 3 feet apart; they consist of thick sheet glass fixed into cast-iron frames. In the top of the main gallery near the closed end there is a man-hole which serves as a convenient means of access to the cannon. During an experiment this opening is securely closed like the man-hole of a boiler, but the top of the gallery also contains three smaller circular openings about 9 inches in diameter, and respectively 7 feet 6 inches, 16 feet distant from the closed end. These are loosely closed before an experiment with wooden plugs, which are blown out when an ignition or explosion occurs, the pressure developed in the gallery being thus relieved. A fourth opening of the same kind, 9 feet 6 inches from the closed end, is used for the application of a Körting's exhaust apparatus after an experiment, to expedite the removal of the after damp. At a distance of 40 feet 6 inches from the brickwork face is fixed a wooden frame; by the attachment of brattice cloth to this frame a space of exactly 700 cubic feet can be separated from the remainder of the gallery, a chamber being thus formed for the reception of a fire-damp-mixture when the experiment involves its employment. The joints in the woodwork of this part of the gallery, and a short distance beyond, are caulked with red lead cement, and the interior of the gallery is washed over from time to time with limewash to protect it against ignition. A hydrant is also provided for dealing expeditiously with any accidental ignition. At the opening of the gallery, and in line with the latter, an ordinary mine railway extends to some distance beyond, ascending at an angle of 4 degrees. A truck loaded with iron is placed upon this, and its propulsion from the mouth of the gallery furnishes a rough indication of the force developed by an explosion in the gallery.

Preliminary experiments were made to ascertain the influence exerted upon the length of flame projected by a blown-out shot, by the employment of coal dust tamping. With the use of clay tamping and a powder charge of 7.4 ounces the flame extended to distances between 9 feet 10 inches and 13 feet, and an increase of the charge to 1 pound 2 ounces did not cause any material increase in the length of flame beyond 13 feet. With the same shot holes (cannon) and with the employment of coal dust tamping, 7.4 ounces of powder produced a length of flame ranging from 29 feet 6 inches to 52 feet 6 inches; and a charge of 1 pound 2 ounces gave a length of flame of 62 feet. The particular coal dust used in these experiments contained 16.2 per cent. of volatile constituents, and ranked as of medium inflammability among the varieties of dusts employed.

In the series of experiments made to ascertain the power of a blown-out shot to raise and inflame coal dust existing in a mine way, the dust was strewn upon the floor in a thin layer, the quantity used being on an average 3¼ pounds per yard run. In some experiments coal dust was strewn upon timbers fastened to the sides of the gallery, to represent the timbering in a mine way, but the results thus obtained with a particular dust did not present any important differences from those furnished with the dust when simply strewn on the floor, other conditions being alike. The extent to which the dust is raised from the floor by a blown-out shot was found to depend not only upon the fineness and physical characteristics of the dust, but also upon the position of the axis of the shot hole in reference to the floor, and upon the consequent extent and violence of disturbance of the dust.

In the comparative experiments with different descriptions of coal dust, about 32 pounds 8 ounces of the dust were always distributed over about 33 feet of the length of the floor starting from the face; the layer of dust being thickest in the center (the deepest portion) of the floor. A charge of 7.4 ounces of powder was always fired once with clay tamping, and once with coal dust tamping either from the same shot hole, or from different shot holes occupying corresponding positions in the wall or face.

The influence exercised upon the length of flame developed by a blown-out shot by the distance to which the dust deposit extended along the floor was investigated with different descriptions of dusts, and was found to vary greatly with the degree of fineness and the inflammability of the dust. Thus, while with a particular dust which was exceedingly coarse and of low inflammability, the flame increased to between 33 and 39 feet, whether the dust was spread upon the floor to distances of 33, 66, or 98 feet, with two other dusts, which were very fine and highly inflammable, the length of the resulting flame increased with every increment of the distance to which the dust extended along the floor; so that when this amounted to about 130 feet, the flame was projected over 16 feet beyond the mouth of the gallery, and extended, therefore, to a distance of at least 185 feet (the distance to which flame extended, under much less favorable conditions, in a cold and damp gallery, in Messrs. Hall and Clark's experiments of 1876, was over 140 feet). Moreover, when either of these two dusts was strewn along the gallery to a distance of 66 feet and upwards, violent explosive effects were always produced by its ignition; columns of flame from 3 to 6 feet in height, followed by dense black smoke, were projected from the vent-holes in the top of the gallery. The results of comparative experiments with various dusts showed that their fineness had generally a much greater influence upon the distance to which they carried flame than distinct variations in their inflammability. When the results obtained by firing 7.4 ounces of powder in a cannon near the floor with different dusts, strewn to a distance of 33 feet, were arranged according to the fineness of the dusts used, it appeared that:—

With *very fine dusts* (of which five were fired) the flame reached between 69 and 102 feet.
With *fine dusts* (of which twelve were fired) the flame reached between 43 and 69 feet.
With *medium dusts* (of which four were fired) the flame reached between 39 and 49 feet.
With *coarse dusts* (of which five were fired) the flame reached between 20 and 39 feet.

The influence of comparative non-inflammability upon the distance to which flame was carried by coal dust was demonstrated, on the other hand, by experiments with an anthracitic coal from the Wurmrevier; the distances to which flame was carried by it (the same dust being used for tamping the charges) ranged from 26 to 30 feet. In regard to the respective influence of inflammability and of fineness upon the facility with which flame is propagated by coal dust, Mr. Hilt points out that the class of coals which may be called of medium inflammability, the volatile constituents in which range from 16 to 24 per cent., are not only among the softest coals, but are characterized by a great tendency to weather or crumble away when exposed to moist air, so that they yield dust which is often as fine as the finest screen flour-dust. It is proposed, in future experiments, to take steps for securing uniformity, as regards fineness, in the different samples of coal dust used, so that the influence of the character of the dust, apart from its mechanical condition, upon the readiness with which it propagates flame, may be ascertained. The comparative experiments in which clay tamping and coal dust tamping were used, with different dusts strewn upon the floor, showed that, with the more easily inflammable dusts, strewn to a distance of about 33 feet along the floor, the description of tamping had no practical influence upon the distance to which the dust flame was carried; whereas with the less inflammable dusts the travel of the flame was considerably extended when coal dust tamping was used.

In discussing the manner in which coal dust operates alone in propagating flame from a blown-out shot, Mr. Hilt does not advance any point of novelty, his views being that, as suggested by Faraday and others, the flame furnished by the dust is due in part to the combustion of the dust itself, and in part to that of the gas developed from fine dust particles by their exposure to heat. He also refers to the property possessed by some fine dusts, quite distinct from that of combustibility, of promoting combustion when in a heated state,

as pointed out by Abel, and confirmed by Mallard and Le Chatelier. With reference to the development of gas from coal dust, when the flame of a blown-out shot is taken up by the dust raised, Mr. Hilt points out that distinct secondary or after-explosions were observed in the course of the Saarb ücken experiments in operating with several descriptions of dust; and that, more especially with one of the dusts most favorable to the propagation of flame, the after-explosion was of a violent character, such as is exhibited by a gas-mixture. These phenomena are evidently due, as suggested by Mr. Hilt and others before him, either to gaseous combustible matter developed from part of the heated coal dust at the first ignition, which remains unburnt through deficiency of oxygen, or to gaseous products developed from dust particles within the highly heated space, after the first inflammation. In either case, the inrush of air immediately following the first dust-ignition would effect the combustion of such gases or vapors with explosive violence. Similar after-explosions, the flame running back violently after the first inflammation, were observed by Abel in the experiments on the effects of coal dust in the presence of very small proportions of fire-damp, which were conducted by him at Garswood Hall Colliery early in 1881. Mr. Galloway, in describing the results of his careful examination of the effects produced by several serious coal-mine explosions, in which dust had evidently played an important part, has pointed out decided indications that secondary or back explosions, had followed upon the first explosion.

A series of valuable experiments was also made by the Prussian Fire-damp Commission on the behavior of coal dust when suspended in air containing proportions of fire-damp insufficient in themselves to produce inflammable or explosive mixtures.

The primary object of those experiments was to determine in what measure the tendency to ignition of, and propagation of flame by, coal dust was increased by the presence in the air of a small quantity of fire-damp, and the results arrived at afforded complete confirmation of the conclusion enunciated by Galloway and established as unimpeachable by the more precise experiments at Garswood, that coal dust is readily brought into operation as an exploding agent by the presence in the air in which it is suspended of a proportion of fire-damp not only so small that its existence is unattended by any danger in the absence of coal dust, but so small even that its existence in the air cannot be detected by the most practised observer through the agency of a safety lamp. MM. Mallard and Le Chatelier having considered that some objections entertained by them to the method of experiment pursued by Galloway and by Abel, and certain experimental results of a negative kind obtained by themselves, were grounds for disputing the correctness of that conclusion, the Saarbrücken experiments are valuable as affording additional data, obtained upon a scale representing the actual condition of things in a mine, which completely confirm its correctness.

These experiments were also directed to the attainment of results tending to demonstrate the comparative mechanical effects produced by ignitions or explosions of coal dust in the total absence of fire-damp, and of dust suspended in air which contained fire-damp in proportions ranging from 1 to 7 per cent. The experiments embraced four series, having the following objects:—

(1.) Determination of the extent of elongation of the flame from a blown-out shot, caused by firing in air containing proportions of fire-damp included in the above range, the charge being tamped with clay.

(2.) Attainment of comparative results by experiments corresponding to the preceding, with the use of coal dust in place of clay, as tamping.

(3.) Determination of the effects produced by blown-out shots, the charges, tamped with clay, being fired in air which contained proportions of fire-damp ranging from 1 to 6 per cent., and the floor of the gallery being strewn to a distance of 33 feet with a coal dust of medium inflammability.

(4.) Attainment of results comparative with (3) by by substituting a very inflammable or sensitive coal dust for the kind used in those experiments.

In the third and fourth series the mechanical effects of the explosions produced were measured by ascertaining the distance to which the loaded truck was propelled up the inclined railway from the mouth of the gallery.

The results obtained in series (1) and (2) were conclusive as to the great effect of coal dust tamping in increasing the length of flame produced by a blow-out shot in air containing small percentages of fire-damp, and in bringing about the explosion of a gas-and-air mixture, which, when clay tamping was used, gave only comparatively slight lengthening of flame with the blown-out shot. With a comparatively coarse coal dust of only medium inflammability, 2 per cent. of fire-damp in the air produced no decided elongation of the flame, which in pure air reached to a distance of 49 to 50 feet. 3 per cent. of gas produced an elongation of the flame of about 14 feet (= 64 feet), and a decided increase in the slight extent to which the loaded truck was propelled by the shots fired with coal dust tamping. With 4 per cent. of gas, the flame extended over 80 feet, and the truck was propelled 7 feet 6 inches, with 5 and with 6 per cent. explosive effects were produced, the flame extending to 115 feet and 134 feet respectively. With the highest percentage of gas, the explosion propelled the loaded truck to a distance of over 46 feet. When highly inflammable coal dust was employed, the existence of only 1 per cent. of fire-damp in the air caused an increase in the length of flame and a propulsion of the truck equal to that obtained with 3 per cent. of gas in the preceding series; 2 per cent. of gas, in the air caused this dust to produce elongations of flame in excess of that obtained with 4 per cent., when the less inflammable dust was used. When the latter percentage was employed in conjunction with the most inflammable dust, the flame flashed instantaneously to a distance of over 101 feet, or a little over three-fifths the length of the gallery, and with 5 per cent. of gas a sharp explosion, followed directly by a back explosion, was produced, the flame extending to 118 feet.

It is admitted by Mr. Hilt that, although the results of upwards of 300 experiments made at Saarbrücken have been accurately recorded, many additional experiments are needed for determining more thoroughly the relative influences of chemical composition, dryness, and variations in mechanical condition upon the comparative inflammability of, and tendency to propagation of flame by, different descriptions of coal dust, both in the total absence of fire-damp and in the presence of small proportions of gas in the air in which a blow-out shot occurs; but it is considered that the following practically important conclusions (confirmatory of those of previous experimentors) are warranted by the results already obtained.

(1.) The *presence of coal-dust* in more or less abundance in the immediate vicinity of the working face, *gives rise to more or less considerable elongation of the flame* projected by a blow-out shot, *whether small quntities of fire-damp be present in the surrounding air or not*,.

(2.)a. *In the complete absence of fire-damp, the elongation or propagation of flame is generally of limited extent*, however far the deposits of dust may extend in the mine ways. If clay tamping is used and the walls of the bore hole do not furnish gas or coal dust at the moment when the shot is fired, 50 feet is about the maximum limit to which flame will be carried by most varieties of dust; this limit is increased to about 70 feet if coal dust tamping is used, or if fine dust and gas are furnished by the action of the fire shot upon the sides of the bore hole.

b.) *There are, however, certain descriptions of coal dust which*, if ignited by a blown-out shot, will not only *continue to carry on the flame even to distances extending considerably beyond the confines of the dust deposits*, but will also *give rise to explosive phenomena or results, in the complete absence of any trace of fire-damp*, which, in character and effects are similar to those produced with some other dusts in air containing 7 per cent. of fire-damp. A calculation, based, firstly, upon a comparison between the proportions of volatile matter found in a dust of this description (from *Pluto* mine), and in specimens of the coked dust collected after an experiment with this dust in the gallery, and secondly, upon the circumstance that the proportions of oxygen and nitrogen were about the same in the original dust and in the coked product,—led to the inference that the proportion of dust used in the experiments (about 33 pounds per 33 feet run) would yield about 2.7 pounds or about 70 cubic feet of gas (if the *whole* of the dust were equally acted upon by the heat), consisted entirely of hydrocarbon, which, if distributed through the cubic contents of about 33 feet length of gallery (572 cubic feet) would furnish a mixture approaching to the proportion of 12 volumes of the gas per 100 of air. Although it is admitted that a very considerable proportion of the dust escapes the action of heat, this calculation is considered to afford an indication that the conditions essential to the production of violent explosive effects may be fulfilled by the action of the heat upon fine dust rich in volatile matters, in the complete absence of fire-damp.

(3.)a. *All the phenomena produced by the burning of, and propagation of flame by, coal dust are intensified by the presence in the air of small proportions of fire-damp*, but such dusts as will *per se* only favor to a limited extent the propagation of flame from a blow-out shot, gives rise only to moderately increased volumes of flame, in the presence of even as much as 3 per cent. of gas, and are not at all capable, under those conditions, of carrying on flame throughout the length of a dust-strewn area; the latter result will, however, be produced, even with such dusts, if the proportion of fire-damp in the air amounts to 4 per cent.

(*b.*) *Certain dusts* which, under favorable conditions, appear to have the power of propagating flame to an indefinite extent in a dust-laden area, the air being free from fire-damp, *will, if only sparsely suspended in air containing fire-damp in some proportion below 3 per cent. be rendered such a gas-mixture susceptible of explosion by a blow-out shot.*

(4.) Special experiments, in which the branch gallery, described as opening into the main gallery near its extremity, was charged with a fire-damp mixture (retained by brattice cloth), demonstrated that *a coal dust ignition or explosion, developed in the complete absence of fire-damp, can communicate ignition to an explosive gas-mixture existing at a very considerable distance from the point of first ignition.*

Mr. Hilt, in submitting these conclusions, is careful to lay special stress upon the fact that *the occurrence of a blow-out shot is indispensable to the production of any and all of the effects* (of ignition, propagation of flame, or explosion), *to which coal dust can give rise*, and he points out that this was practically demonstrated by the accidental bursting of one of the cannons in the course of the experiments, when no inflammation of coal dust was produced. He therefore emphasises the fact that "*the part played by coal dust is not nearly so dangerous as it might appear from a superficial examination of the Saarbrücken results*," and he considers that it might be possible to abolish almost completely the dangers arising from the existence of coal dust in mines, if absolute security could be attained against the occurrence of blow-out shots.

He refers to a proposal made to substitute dynamite for gunpowder, as a means of pre-

venting the projection of flame by blown-out shots, and states that certain promising results had been attained in this direction by Mr. Menzel, Director of Zeche Maria-Anna, near Bochum. It will be seen, further on, that any hopes, which may have been based upon those results, as to the abolition of danger from the occurrence of blow-out shots, in localities *where explosive gas-mixtures exist*, by the *simple substution of dynamite for gunpowder*, are delusive. It appears, however, from a recently published account of further experiments, regarded as conclusive, which have been carried out at Neunkirchen (Saarbrücken), since the publication of Messrs. Hilt and Margraf's reports, that, in the complete absence of fire-damp, even the most inflammable descriptions of coal dust are not inflamed by blown-out dynamite shots. Even the breaking up of a block of coal, thickly covered with inflammable dust, by a dynamite shot, did not lead to any ignition of dust. As the details of these experiments have not yet been published, information is wanting as to the nature of the arrangements by which, with the employment of dynamite in the Neunkirchen gallery, veritable blow-out shots were obtained. They connect the Saarbrücken results with extensive experiments on special methods of applying dynamite, which have been carried out under our instructions by Mr. Galloway, and which will be presently dealt with.

The latest experiments in the gallery at Neunkirchen have added two other important links to the chain of evidence as to the dangers attending the existence of dust-accumulations in coal mines. It had already been experimentally established, that a fire-damp mixture which exists at a distance from the seat of a blown-out shot can be fired by the transmission of flame by coal dust; the converse has now been demonstrated. That part of the main gallery in the Neunkirchen apparatus which can be converted into a gas-chamber by means of brattice partitions was filled with a 7 per cent. gas mixture (occupying 700 cubic feet); the floor of the main gallery was quite free from dust, so that there was nothing to aid the transmission of flame to the branch gallery, the floor of which, at a distance of over 56 feet from the gas chamber, was covered with one of the specially inflammable dusts previously experimented with. The gas-mixture was fired by the blowing out of a shot tamped with coal dust; the dull thud of the explosion was immediately followed by the sound produced by violent burning, the side gallery was seen to be filled with flame swaying to and fro, and a volume of flame several meters in length was projected into the air from its extremity, followed by a dense smoke cloud. The flame extended 144 feet along the main gallery; the wooden door with which its opening was closed was completely shattered, the iron framework being much injured, and the only portion of the side and main galleries which escaped more or less serious damage was that part of the latter which intervened between the seat of the gas explosion and the side gallery. The greatest destructive effects were produced in the part where the ignition of coal dust occurred. Further experiments demonstrated that the flame produced by the ignition of coal dust, spread along the main gallery up to within 26 feet of the side gallery, in the complete absence of fire-damp, developed an explosion in the latter, which was strewn with coal dust and was also free from fire-damp.

Very instructive experiments have also been made with moistened coal dust, which will presentiy be referred to.

In 1882 M. M. Mallard and Le Chatelier published the results of their inquiries into the part played by coal dust in mine accidents; they state their views as to the value of the experiments made and conclusions drawn in by others in reference to this subject; they also describe certain experiments made by themselves for the French Commission, of which they were members; and they arrive at conclusions opposed in important respects to those of previous experimenters. After referring to the fact, already pointed out, that Faraday and Lyell were the first to indicate and discuss, in 1844, the possible part taken by coal dusts in mine accidents, and after epitomising the subsequent history of the subject, they state that, at the period of their giving attention to it, the part played by coal dust in mine accidents was far from being completely elucidated, some established facts having been supplemented by numerous hypotheses. They then proceed to what they consider a complete examination of the question.

The records of various accidents ascribed to the ignition of dust alone, suspended in the air, and brought about either by the flame of a lamp, by a blown-out shot, or by a local explosion of fire-damp, are discussed by them, and while admitting that certain coal dusts suspended in air may produce inflammable mixtures with it, which may be ignited by a lamp flame, provided the dust be sufficiently thickly suspended, they maintain that the amount of dust which can exist suspended in the air even of a very dusty mine is insufficient to produce such an inflammable mixture. They account for two accidents at the Montmartre Pits in 1869, due to the ignition of very thickly suspended dust by a flame, by the production of exceptionally dense dust clouds, but point out that no explosive results attended these ignitions, and that the flame did not extend beyond the thickest portions of the dust cloud. With respect to eight accidents, caused by blown-out shots, which occurred in different pits in France between 1871 and 1880, in localities where no fire-damp had been known to exist before the explosions, and which had been ascribed to dust only, they show that the absence of fire-damp could not be decidedly affirmed in several of those cases. In others, in which men received injuries from burning at distances of about 33 feet and 39 feet from the seat of the shot, they admit that the casualties may be considered to have been wholly caused by the ignition of coal dust. They also examine into the statements made by Mr. Galloway respecting the accident which occurred in October, 1871, in the Fowler Pit at Pontypridd, when several men were more or less seriously burned, no actual explosion having occurred, but traces of the effects of flame being visible up to a distance of about 165 feet from the seat of the blown-out shot. Although Mr. Galloway estimated the amount of fire-damp in the air of the pit at only about 0.54 per cent., from the results of special experiments made after the accident, at a time when work has been suspended in the pit for twenty hours, they considered that this threw no light upon the proportion which might have existed in the air during the working, as the coal worked was highly charged with gas (the existence of abundance of gas in other parts of the pits having also been established). Taking all the circumstances together, they incline to the belief that this accident could not with confidence be ascribed to the ignition of coal dust alone.

While admitting that some of the examples quoted establish the fact that mine accidents can be caused by the ignition of coal dust in the absence of fire-damp, they come to the conclusion, from certain data furnished by some of these accidents, that the flame produced in such instances, even when the coal dust is of very inflammable nature, extends but little further than the flame which would be produced by the blown-out shot itself, in the absence of dust. They then proceed to the examination of instances of supposed coal dust explosions caused by local fire-damp explosions, which include two calamitous accidents at the Cinq-Sous Pits at Blanzy, besides the accidents at Llan Colliery, near Cardiff, (December, 1875), at Dinas (January, 1879), at Seaham (September, 1880), and at Penygraig, (December, 1880), all of which were made the subjects of investigatien by Mr. Galloway, whose arguments, in favor of their being chiefly due to coal dust, are discussed in detail. It is considered that the discovery of incrustations of coke dust, which is of frequent occurrence, and is dwelt upon by him as very weighty evidence in favor of coal dust having exercised important if not primary functions, does not prove that the explosion is to be mainly ascribed to coal dust, but simply shows that the temperature developed by the explosion was sufficiently high to submit the finely-divided coal dust to partial charring or distillation. They consider the only warrantable conclusion to be, that the coal dust had played a more or less important part, which might have been quite secondary, through the agency of the gaseous matters expelled from it by the action of the fire-damp explosion. It is pointed out that this development of gaseous matters from the dust may occur,in great measure, after the actual accident, and that the destructive influence even of those gaseous products may consequently be almost *nil*; or, that the dust which is raised by the explosion may even be only heated sufficiently to soften it and cause it to adhere to the timbering, without its undergoing any appreciable decomposition; finally, that the combustion and coking of dust may continue to proceed gradually, for a more or less protracted period, after the explosion.

As regards the supposed absence of fire-damp in any appreciable quantities before the occurrence of explosions which have been attributed to coal dust, Mallard and Le Chatelier point out that the very best method of searching for fire-damp hitherto universally employed, namely, by means of a safety-lamp flame, does not admit of the detection of smaller quantities in the air of a mine than 3 per cent., and that, in actual practice, miners, who are, as a rule, badly enough trained to this class of observations, are unable to recognize the presence of less than 4 per cent. while, on the other hand, a proportion of 6.5 to 100 of air sufficies to produce an explosive mixture;so that there is but a small margin between the point when the presence of gas is begun to be suspected and when it assumes dangerous proportions.

They assert that many causes may operate, individually, in rapidly raising the proportion of gas in the air of a mine from 4 to 6.5 per cent., either by diminution of the supply of air, or by increasing the volume of fire-damp which passes into the air. They state that the causes which, in their opinion, may lead to these results, are too numerous to be particularized, but they specify those which they consider most important. With the exception of the possible occurrence of sudden outbursts of the accidental liberation of gas accumulations from old workings and goaves, and of a possible stoppage of the ventilating machinery for brief periods (during lubrication of the bearings, etc.), it cannot be conceded that the causes cited can account for the explosions, which have been attributed mainly to coal dust, as being primarily due to an unexpectedly rapid production of an explosive atmosphere over a more or less considerable area of a mine.

In summing up, Mallard and Le Chatelier

confidently maintain that no coal mine accident of any importance can be attributed, even with some claim to probability, to the action of coal dust. They maintain that all explosions of magnitude which have been solely attributed to coal dust, have occurred in mines in which fire-damp occurs; that the possibility of coal dust *per se* giving rise to an important explosion, could only be established by the occurrence of an explosion in a mine in which the total absence of fire-damp can be absolutely demonstrated; and that the impossibility of dust alone giving rise to extensive explosions is demonstrated by the fact that lignite mines, which are generally very dusty, the dust being extremely inflammable, but which are at the same time almost free from fire-damp, have never yet been visited by accidents of this class. They remark that the readiness with which fire-damp accidents are ascribed to coal-dust, is due to the fact that the latter is visible, while fire-damp is invisible. *Before* an accident, dust has been seen in all parts of a mine; *during* the accident the smoke produced by the destructive distillation of the dust is seen to escape from the pit's mouth, and, *after* the accident, coke deposits are found adhering to the timber. The ignition of small quantities of dust suffices to produce well-marked appearances which cannot escape anybody's observation. On the other hand, fire-damp is invisible and readily escapes a search for it, carried out under normal conditions; the sufferers who have witnessed the explosion can give no evidence as to its character, and it leaves no visible distinctive traces.

Such are the arguments which Messrs. Mallard and Le Chatelier oppose to the view that coal dust has played the chief part in certain disastrous explosions. Although it must be admitted there is much force in their statement that the particular results of observations made after explosions, which have been advanced in favor of that view, might equally obtain in the case of unquestionable fire-damp explosions in dusty mines, the suggestion that no accident of consequence can be attributed to coal dust alone cannot be said to receive any substantial support from the arguments advanced, and has been absolutely negatived by the Chatham experiments, and still more completely by the results obtained at Saarbrücken. In comparison with these, no importance can be attached to the few negative results obtained by Mallard and Le Chatelier in experiments, the conditions of which, as representing some slight approach to actual practice, do not even compare favorably with those of Galloway, Abel, and others whose results they were designed to combat, in substantiation of adverse criticisms.

On two points, nevertheless, the French experiments afforded complete confirmation of the conclusions arrived at by Galloway and by Abel, viz., that the inflammation of, and propagation of flame by, coal dust are promoted by the presence of fire-damp in the air in proportions insufficient to produce explosive mixtures *per se*; and, that perfectly incombustible porous dusts, if suspended in air containing a proportion of fire damp insufficient to produce inflammation or explosion, will upon some particles becoming incandescent on passing through, or being enveloped by, a flame, determine the ignition of the gaseous mixture. Mallard and Le Chatelier arrived at the confirmation of the latter fact by a method of experiment different from that originally pursued by Abel, and the circumstance that they did not find the flame thus developed by a non-inflammable dust to be propagated by its agency throughout the entire gas-mixture (which was always the case in the experiments made at Garswood) was obviously due to the very small diameter of the channel in which their experiments were made.

The trustworthiness and conclusiveness of the experiments made by Galloway, on the behavior of coal dusts suspended in air currents in the presence of small proportions of fire-damp, are made the subject of criticism by Mallard and Le Chatelier, chiefly on the following grounds: that information is wanting regarding the velocities of air-currents, and the natures of the dusts, used in some of his experiments; that the introduction of dusts into mixtures of air and gas, produced in the apparatus employed, must have affected the proportions in which these were intended to be used, and that no proof was obtained that the air and gas were intimately and uniformly mixed in the currents passed through the apparatus. As the same criticisms are also directed against the results obtained by Abel in the experiments (bearing upon the Seaham inquiry) conducted at Garswood, partly in the presence of members of the Commission, it can at any rate be positively stated that they do not apply in this case. It may be granted that the introduction or suspension of dust-particles in currents of air, or of *a gas-mixture of previously determined velocity*, travelling along channels of considerable dimensions, will to some extent reduce the velocity of the current; but, however, great such a retarding action may be, it cannot affect the relative proportions of gas and air in a gas-mixture produced at a distance from the point where the dust cloud is raised by, or projected into it. As regards the intimacy and uniformity of the mixtures of gas and air passed through the Garswood apparatus, the construction of the latter was carefully elaborated with the special aim of insuring the fulfillment of these self-evidently fundamental conditions to the attainment of trustworthy results, and the success of the precautions taken in this direction was conclusively established by the thoroughly uniform results, (closely according with the calculated requirements), furnished by analysis of samples of the gas-mixture collected from different parts of the apparatus in the course of the experiments. M. M. Mallard and Le Chatelier admit that the sources of fallacy which they assume to have existed in the experiments criticised by them, actually obtained in the experiments which they themselves instituted with the view of controlling those of previous experimenters, and which furnished chiefly negative results.

It may therefore be confidently maintained without any reference to the recent Saarbrücken experiments (which have so completely confirmed the results of the Garswood experiments on this head), that M. M. Mallard and Le Chatelier have allowed themselves to be led to an erroneous conclusion, when they state that "it appears at any rate quite certain that the influence of fire-damp upon the combustibility of dusts, if not altogether *nil*, is at least much slighter than was at first believed."

The most emphatic refutation of this conclusion, and confirmation of the established facts which it combated, have been furnished by the Saarbrücken experiments, even although these are, as yet by no means complete. On the other hand, although those experiments have conclusively demonstrated that particular, exceptional, coal dusts may, in the complete absence of fire-damp, and through the agency of a blown-out shot, give rise to disasters approximating in their character and extent to those caused by the combined action of fire-damp and dust, the results and conclusions arrived at by the Prussian Commission show that these gentlemen will be as little disposed as others who have the subject to dissent from Mr. Galloway's statement, that he* "may safely claim that no earlier author has gone the length of crediting coal dust with the role of principal agent and relegating fire-damp to a secondary position in coal mine explosions. Certainly, no one will be disposed to admit that any claim approaching such an extreme has ever been advanced by others, or that it is at all warranted by the data which actual explosions and conclusive experiments have combined to furnish.

In emphasising this claim, Mr. Galloway does not appear to have realized the fact that *if dust were the principal agent* in coal-mine explosions, *every* blown-out shot occurring in a *very* dusty and dry mine should actually be attended by a more or less disastrous explosion or conflagration, and that, looking therefore to the enormous amount of powder expended in shot-firing in this and other countries, and to the not inconsiderable proportion which blown-out shots must constitute, in many localities, of the total numbers of shots fired, disastrous coal-mine explosions should be of more than daily occurrence, if his view were correct.

The following facts relating to the part played by dust in coal-mine explosions may however, now be regarded as conclusively established:

1. The occurrence of a blown-out shot in working places *where very high inflammable coal dust exists in great abundance* may, *even in the total absence of fire-damp, possibly* give rise to violent explosions, or may at any rate be followed by the propagation of flame through very considerable areas, and even by the communication of flame to distant parts of the workings where explosive gas-mixtures, or dust deposits in association with non-explosive gas-mixtures, exist.

2. The occurrence of a blown-out shot in localities *where only small proportions of fire-damp* exist in the air, *in the presence of even comparatively slightly inflammable, or actually non-inflammable but very fine, dry, and porous dusts*, may give rise to explosions, the flame from which may reach to distant localities where either gas-accumulations or deposits of inflammable coal dust may be inflamed, and may extend the disastrous results to other regions.

It may be accepted that the systems of ventilation now in general use have, in the absence of very considerable accidental contamination of the air by sudden outbursts or other possible causes, reduced the amount of fire-damp which can exist in the atmosphere of even a fiery mine to proportions which are not only quite innocuous *per se*, but which can only be detected by much more delicate means than the most sensitive lamp flame, applied by experienced observers. Moreover, as has just been pointed out, even the complete absence of fire-damp might not in some cases, though these may be very exceptional, preclude the possibility of the development of serious explosions by the occurrence of blown-out shots in very dusty localities.

The following appear, therefore, to be the only possible means of guarding against the occurrence of explosions from shot-firing during the working of coal or stone:

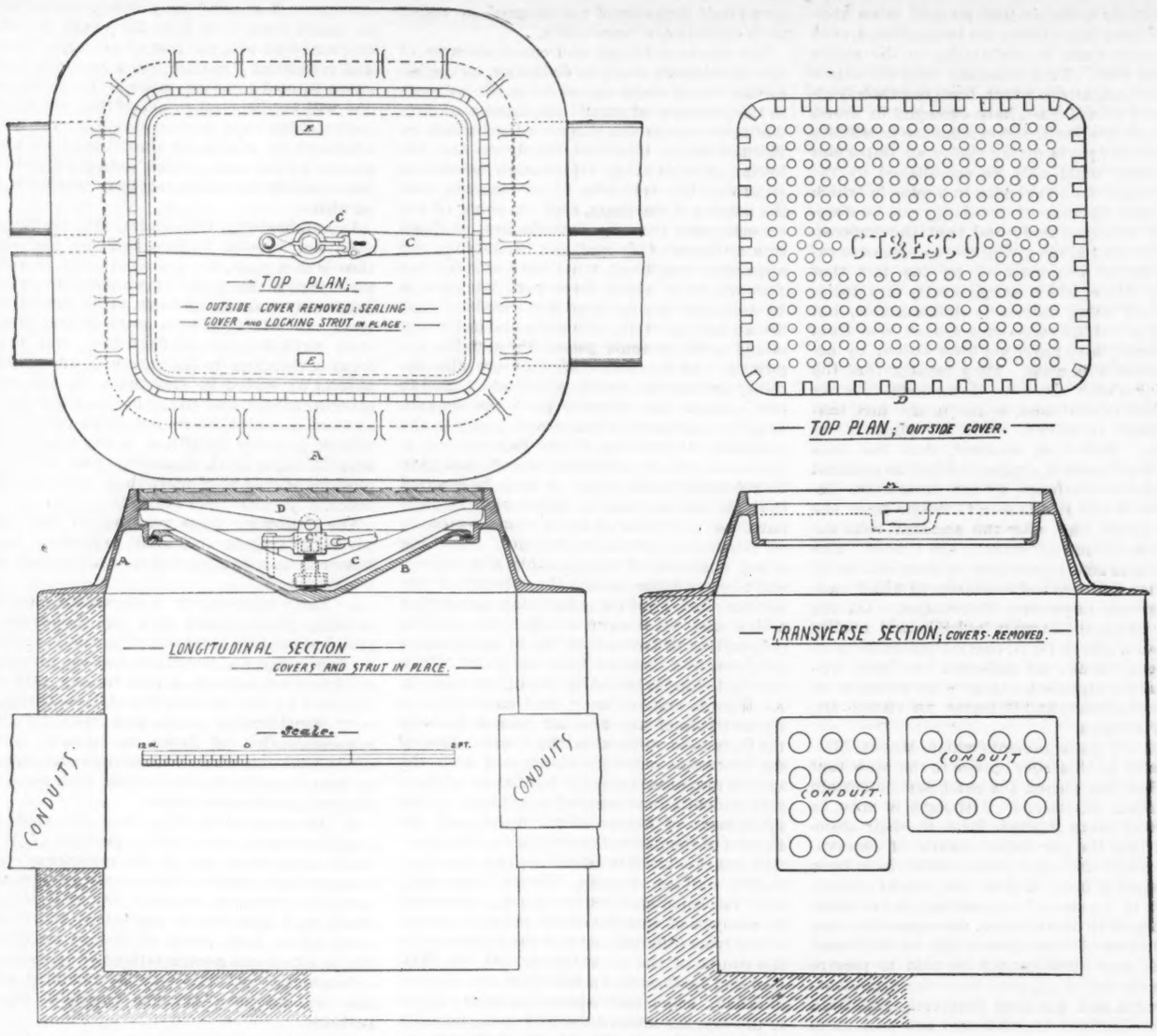
I. The removal of dust as completely as possible from the working places;

II. The provision and thoroughly efficient adoption of simple and effectual measures for rendering dust innocuous in the presence of a blown-out shot;

III. The discovery of means for preventing the possible occurrence of blown-out shots;

IV. The adoption of particular explosive agents or of particular methods of using such

*Proceedings of the Royal Society, vol. 37, page 49, 1884



Manhole and Manhole Covers; N. Y. Electrical Subways.

agents, which deprive a blown-out shot of its danger by ensuring the total absence of flame or of highly heated solid matter when the shot is fired;

V. The substitution, for explosive agents, of similarly efficient methods of bringing down coal and stone, which are quite free from the special dangers attending the use of those agents.

(TO BE CONTINUED.)

Manhole and Covers for the New York Electrical Subway.

We are indebted to Mr. John Thomson, M. E., the engineer of the electrical subway now being laid in this city on Sixth Avenue, for the following illustration and description of the form of manhole and manhole covers devised by him to meet the demands of the new system.

The chief requirement in a manhole for an electrical subway, is that it shall perfectly exclude all water and, more important still, shut out all gas that may leak from adjoining mains; otherwise a destructive explosion might result from the accumulation of the latter at some point. Another requisite is, that while the sealing cover must be perfectly water and gas tight, it must be so arranged that the inside of the manhole shall be easily accessible to authorized employés, and yet be secure against unlawful tampering. While the manhole and cover to be desbribed are necessarily yet in their experimental stage, several weeks' use have demonstrated no defects, and the inventor feels assured that his device will do good service.

The manhole is built of brick carefully laid in hydraulic cement and rests upon an unusually heavy and solid concrete base. The outside of the wall is carefully sheathed with what is known as the "Wootten dampcourse," a species of jute cloth into the fibres of which bitumen is thoroughly rolled; this material having proved very efficient in buildings as a preventative against the penetration of moisture from without, it is here used for a similar purpose. Inside, the walls are protected by the process of the "Brick and Stone Water-proofing Co.," which consists essentially in applying to the artificially heated inside surface a preparation of paraffine containing about 2 per cent. of creosote. This inside coating is especially used as a protection against the leakage of gas and the creosote is used as a destructor of fungoid growth. As built on Sixth avenue these manholes have the following inside dimensions:—Length, 48 inches; width, 42 inches, and height to base of cover, 44 inches; these dimensions will, of course, vary with local conditions.

The manhole cover is made in several distinct parts, as shown in the illustration. Immediately resting upon the brickwork, and free to expand and contract without disturbing the masonry, is the casting *A*, which contains a sunken seat for the sealing cover *B* and an upper seat for the top-cover *D*. In the part *A* is cast a bayonet-lock slot to be used in connection with the locking strut *C*, and this casting is further ribbed vertically to increase its strength.

The sealing-cover *B* is simply a basin-like casting resting upon the seat in *A*; to secure a tight joint a light rubber tube-gasket is first stretched around the edge of this cover and held in place by the small flange shown.

The locking-strut *C* is likewise of cast-iron. This strut has in its center a cored-hole sufficiently recessed at the botton to receive an ordinary nut, and when in use this strut is dropped into the slots shown in *A*, given a slight turn sufficient to bring its ends under the rim of the casting *A*, and then an ordinary bolt is screwed down into the nut before described, and onto a seat in the center of the sealing-cover *B*. This operation forces down the cover *B*, flattens out the gasket and secures the joint. The device C', shown above the head of the bolt, is made up of two hinged castings which close around the head of the bolt in *C*, and can be fastened there by

a padlock, thus effectually preventing the application of a wrench to the bolt, and consequently any movement in or removal of the sealing-cover *B*.

The top-cover *D* is a plain casting as shown, with deep bottom ribs to strengthen it against the pressure of traffic; the shape given the strut and sealing-cover permitting this arrangement of ribs.

In this cover design the intention throughout has been to reduce all parts to their simplest forms, and to avoid machine-work. As here illustrated, the only exceptions to cast-iron forms, which can be used as they come from the sand, are the ordinary commercial bolt-and-nut, the rubber gasket and the padlock.

The use of this man-hole in the distribution of wires, and the general plan of wire distribution as proposed, will be described in a forthcoming article.

LITERATURE.

Roorkee Hydraulic Experiments; abstract of a paper by E. S. BELLASIS (which will be printed in the "Transactions of the Society of Engineers" for 1886).

This paper is a review of the hydraulic experiments lately carried out by Major A. Cunningham, R. E., on the Ganges canal. The experiments have been discussed at the Institution of Civil Engineers,* but this paper deals chiefly with questions which were not discussed there. It shows that many of the conclusions to be drawn from the experiments—and some of the most important ones—are different from those at which the experimenter arrived. The following are the principal points considered:

Questions connected with the practical observation of Velocity and Slope.

1. Double floats should be designed on a different principle from that laid down by Major Cunningham. The lower float should consist of two vertical plates cutting each other at right angles, and it should be of large size so that the influence of the connecting cord may be slight. The submerged floats used at Roorkee were balls of 1¾ or 3 inches diameter. They were much too small, and the influence of the connector was far too great, as Major Cunningham has himself pointed out. If the size of a submerged float is proportioned to the size of the stream, there is no reason why as good results should not be obtained in deep water as in shallow. Double floats are, however, best suitable to slow streams, the sources of error increasing with the velocity.

2. The experimenter attempts to show that a rod for measuring the mean velocity from the surface to the bed, should have a submerged length equal to about .94 of the depth of water. But if, as is probable,† the velocity decreases very rapidly near the bed, just as it does near the sides, the proof given does not hold good and the rod should reach as nearly as possible to the bed. The length of rod actually used was generally less than .94 of the full depth, and the discharges and "mean velocities on verticals" were consequently somewhat over-estimated.

Current-meters when properly constructed and used are as accurate as rods, and (except in a slow stream) more accurate than double floats, and occupy much less time than either.‡ They can also be used in any stream however irregular. The conclusion of the experimenter that rods should supersede all other instruments for measuring mean velocity on a vertical is therefore wrong.

3. The Roorkee observations show that the surface slopes at opposite banks are often unequal and that owing to the oscillation of the water-surface the slope is constantly changing. The slope measurement should therefore be made at both banks, and should be frequently repeated. Major Cunningham arrived at the same conclusion with the addition that the observations of water-level at the different points should be simultaneous, but he now admits that this last condition is unnecessary. In rather more than half of the experiments the slope was measured at one bank only.

4. The slope was obtained by observing the water-level at points 2,000 feet apart, but at some of the sites the sections of the stream, and consequently the slope, varied greatly within this length, so that the slope as measured did not agree with the local slope at the point of gauging. This in some cases constitutes a serious source of error. The only way to obtain the local slope in cases of irregular channels like the above, would be to dig two still-water channels from points situated a little above and below the point of the gaugings, both leading up to one point where they would be separated by a partition, so that the difference of level could be accurately and frequently noted. The oscillation of the surface would be much less near the partition than in the stream.

Distribution of the Velocities in the Cross-section of a Stream.

1. If in any channel the mean velocity be altered by altering the slope, the depth of water remaining unchanged, the mean velocity on every vertical line in the section will alter in the same proportion, or, the ratios of the velocities on different verticals are independent of the velocity of the stream. This conclusion was arrived at by Major Cunningham, and is now confirmed. Whether the velocity alters in the same proportion at each individual point as well as on each vertical, there is not sufficient evidence to show.

2. In a rectangular channel the ratios of the velocities on different verticals are independent of the depth of water in the channel, and therefore (from the last law) are constant in any given rectangular channel, however the depth and velocity may change. This law was stated by Major Cunningham, but in a less definite form, and on slight evidence, and he supposed it to apply to all channels, though now admitting its restriction to those of rectangular section. The evidence in favor of both the laws is now considerably strengthened.

3. It follows from the above laws that the coefficient giving the ratio of the mean velocity on the central vertical is independent of the velocity of the stream. The experiments show that it depends on the shape and size of the cross-section. In a channel whose bed is level across the coefficient will be greater the wider the channel. If the sides are vertical it will be independent of the depth of water; if sloping it will decrease as the water-level rises. If the bed is not level across, the coefficient may either increase or decrease with the water-level, according to circumstances. Major Cunningham considers that these laws regarding the coefficient are "preferable" to those given in his book.

4. The laws of the variation of the coefficient which gives the ratio of the mean velocity in a channel to the central *surface* velocity are not very clear, but it is certain that this coefficient also depends on the size and shape of the cross-section, and it is probably independent of the velocity. Any published coefficients professing to show the ratio of the mean to the central surface velocity must be quite unreliable. The ratio will be different in every different form of channel and in the same channel with different water-levels. Major Cunningham shows that Bazin's coefficient, which depends only on the hydraulic radius, is unreliable, and Prony's (as given by Neville) is equally so.

Major Cunningham states that if the mean velocity in a stream is to be inferred by observing the velocity on the central vertical, the coefficient to be applied must be found by observation at the site. It should be added that the coefficient will generally vary with the water-level even at the same site. The same is true if the central surface velocity be observed. In either case, however, the mean velocity may be ascertained approximately by assuming the value of the coefficient to be the same as it had been found to be at some site of nearly the same section. If the bed is level across and the change of water-level small, the same coefficient will do for different water-levels.

5. The resistance of the air is not sufficient to account for the depression of the maximum velocity below the surface, and it certainly is not the cause of the *greater* depression near the sides of a rectangular channel as compared with the center. This conclusion is contrary to that arrived at by the experimenter, though now admitted by him to be correct.

Relation between the Velocity in a Channel and the Slope and Hydraulic Radius.

The usual formula expressing the relation between these quantities is $V = C\sqrt{RS}$. Major Cunningham observed V, R and S in a great number of cases, and then by putting

$$C = \sqrt{\frac{V}{RS}}$$

he found values for the coefficient C.

These values he compared with the published coefficients of Kutter and Bazin and he found the agreement in many cases to be very bad. He concludes that the published coefficients are unreliable. The real cause of the disagreement is that the values of C, as found experimentally, are wrong, owing to the non-agreement of S, the local slope, with S', the observed slope. S in the formula means the local slope. The value of C obtained is too great or too small, according as S' is less or greater than S.

At some of the sites in the earthern channels, where the stream was uniform, S' and S agree closely, and C agrees extremely well with Bazin's coefficient for "earthwork" and Kutter's for "earthwork in average order." In other cases S' exceeded S, and the experimental coefficients fall short of the published ones. In the masonry channel the experimental coefficients are less than those of Bazin and Kutter for brick-work; but owing to the compressed nature of the case—the "slope-gauging" being rarely outside the masonry channel—it is impossible to say whether the values of C obtained were too small or not. All that can be said is that the observations are quite unreliable.

The general conclusion is that the experiments in many instances establish the accuracy of the published coefficients, and nowhere establish the contrary.

Elements of Geodesy. By J. HOWARD GORE, B. S., Professor of Mathematics in Columbian University, New York: John Wiley & Sons, 1886. Octavo, 282 pages. Price, $2.50.

The need of a systematic elementary work on geodesy has been long apparent. The annual reports of the U. S. Coast and Geodetic Survey contain many papers relating to the subject, but they are usually of a high technical character, and hence unsuited to the capacity of learners. The treatise of Clarke, published at Oxford in 1880, is of a similar nature and cannot be used as a text-book. The works of Merriman on the Figure of the earth, and of Wright on the adjustment of observations, treat of those particular geodetic problems in a satisfactory manner, but discuss field operations only incidentally. The appearance of the systematic work of Prof. Gore will hence tend to supply the long felt-need of a text-book for technical schools and of a manual for field practice.

The book opens with a historic sketch of geodetic operations, which gives an excellent synopsis of the efforts of scientists to obtain a precise determination of the size and shape of the earth. We cannot agree with the statement that Newton would have failed to demonstrate the law of gravitation, had he known the facts regarding the error of these seconds in Picard's measurement of an arc of the meridian, for evidently that small error in latitude could not appreciably affect the resultant diameter of the earth for use in an astronomical problem. This chapter, like most of the others, closes by giving a useful list of literature on the subject.

Chapter II treats of instruments and methods of observation in which the historic method is also largely followed. The method of determining the excentricity and the probable error of graduation of a theodolite, as followed by the Coast Survey, is here set forth in detail, and rendered very clear by a fully worked out example of an actual test. The instruments and methods for the determination of latitude, longitude and azimuth, are not discussed by the author, as these operations form a part of practical astronomy, and are fully set forth in works on that subject.

Chapter III treats of the measurement of base lines in a very satisfactory manner, and a large number of instances are given, showing the degree of precision attained in different countries and with different kinds of apparatus.

Chapter IV is devoted to the subjects of reconnoissance, and angle observations, and is largely taken from the reports of the Coast Survey. The author recommends the use of a direction instrument, and does not speak favorably of the method of repititions for ample observations, while Jordan and some other authorities seem to regard the latter as in general more preferable.

Chapter V is on the method of least squares, which is treated briefly and not as thoroughly as the other subjects. No satisfactory definition of probable error is given, for instance, and fully one half of the chapter is not at all related to the subject of least square, being a discussion of the best shaped triangles and of the influence of the error in an angle or in a base upon the computed parts.

The calculation of the triangulation, namely, the adjustment of angles at a station, the determination of spherial excess, and the adjustment of angles in triangles and quadrilaterals, occupies the next chapter. The adjustment of chains of triangles is not attempted, and the discussions are necessarily very short and imperfect compared to those given in the treatise of Wright.

Chapter VII deduces the formulas for the computation of geodetic latitudes and longitudes, and Chapter VII treats of the figures of the earth. In an appendix are given a number of important tables for use in computations, based on Clarke's elements of the terrestial spheroid.

The author in his preface says that the advanced student and practised observer will find nothing new in the work, and may perhaps lay it aside with feelings of disappointment, but that it is hoped that the beginners will be enabled to get a clear insight into the subject, and feel grateful that the discoveries and writings of many have been so condensed or elaborated, as to make the study of geodesy pleasant. We feel sure that the labors of Professor Gore will be appreciated not merely by beginners, but by teachers and practitioners as well, for the importance and value of geodetic work is daily becoming more apparent, and his presentation of the subject cannot but have a stimulating effect in hastening the time when all surveying work shall rest upon the basis of a geodetic triangulation.

*Min. Proc. Inst. C. E., vol. lxxi. †Ibid., pp. 88, 89.
‡See Min. Proc. Inst. C. E., vol. lxxi. pp. 40, 41 and 56-88

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MAGAZINE RENEWALS.

The *Century Magazine* closes its yearly volume with the *October Number*. Renewals are in order for November. The price to ENGINEERING NEWS subscribers and their friends is $3.55; with ENGINEERING NEWS, $8.55. The new *Scribner's Magazine* will be out December 1, and we will make liberal terms to subscribers. *Harper's Monthly* is renewable on December 1 st. Orders ought to be sent in in November to save the publishers trouble.

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THE Metropolitan Transit Co. are again claiming the right to run an elevated railroad up Broadway in this city. They base their claim on an act of 1872, and would span the street from curb to curb. The present agitation is to ascertain what the company will have to pay the city for the right to operate the road.

As might be expected the two underground roads and the Broadway surface road all vigorously oppose any such new departure. And while more rapid transit is needed in this city, it will probably be some time before the sunlight is shut off from our Broadway loungers.

A Canadian correspondent objects to a statement made in a paper on "Economical Construction of Railways" lately read before the Institution of Engineers, and commented upon by us at the time. The writer of the paper referred to says "that whereas Canada formerly "bought her bridges in England she now buys them in the United States."

To this our Canadian friend replies that "Canada makes her own bridges;" but makes them on American designs from raw material imported from England. Our correspondent adds that were the designs English "the results would doubtless be different notwithstanding a 25 per cent. protective tariff." and that it is the "English design" that is at fault.

We also acknowledge the further statement made by the writer that Canada is capable of turning out bridge work of a most excellent character, as is proven by the late work at St. Johns and at the Lachine bridge. It would be well for Englishmen nearer home did they show some of the sense and progressive spirit of their Canadian colony in the adoption of bridge plans, And the frank statement made by our correspondent, himself a member of the Institution of Civil Engineers, as to the manufacture of the American bridge from raw material imported from England is rather a knock-down argument against the matter of English design.

R. P. STUDLEY & Co., of St. Louis, Mo., have issued a "Ballast, Tie and Rail Record" that seems to us to be the most convenient thing of the kind out. It is in book form, 10¼x4½ inches, so that it can be carried in the pocket and readily opened. It is ruled for a record, showing by a system of colors, iron and steel rail, miles laid, weight per yard and date of laying. Ties, timber, and preserved or not preserved, with dates and number of miles, Ballast, character of, depth, dates and mileage. In convenience for use and reference, this book is certainly ahead of the profile paper roll usually employed for this class of record.

The Water-Tower Failure at Gravesend, L. I.

This water-tower was recently completed for the Kings County Water Co. (N. Y.), and was located near Gravesend on Long Island; it was intended to supply the villages about Coney Island. Its failure while under test was noted in our last issue.

We give the following general description as obtained by our reporter on the spot; although as he was unable to inspect original plans, and had a very bad wreck upon which to base his deductions, the actual dimensions as standing, may vary slightly from those given:—

When finished the tower was 250 feet high with a diameter of 16 feet for a height of about 59 feet; it then decreased in a length of 25 feet to a diameter of 8 feet, which was continued to the top. The foundation was apparently solidly built of brickwork and concrete, and was 22 feet in diameter. The only evidence of anchorage was in a 4-inch bolt in the center of the bed-plate.

The material used in its construction was steel, in sheets 5 feet high by 7 and 9 feet long; these plates were 1 inch thick in the lower portion, and decreased to ¼ inch at the top. The bed-plate, or bottom of the tower, was made up of 1 inch plates, and to this the lower ring of the tower was secured by a 6 × 6 × 1-inch outside angle iron, double riveted. The second ring of plates was connected with the bed-plate by two sets of inside stays made of 2½ × 1 inch bars, twisted at the middle and fastened to the sides by three rivets, and to the bed-plate by two bolts through the T-shaped foot of the stay. These stays ran from the top and bottom of the second ring and extended in, at the foot, 21 and 39 inches from the circumference of the circle; they were spaced about 18 and 24 inches apart around the circle. The plates in the tower itself were lap-jointed and triple riveted on the vertical seam for the first ring, and then double-riveted on vertical seams above, for a very considerable height. The largest rivets used were 1 inch in diameter.

The base and top of the conical connecting portion were connected with the cylindrical parts of the tower, in addition to the seam riveting, by six T-irons, 4 × 4 inches by 9 feet long, of doubtful purpose. These irons were secured to the sides of the tower by three 1 inch bolts at the top, and two 1 inch bolts near the bottom of the bar, Ten wire-rope guys had been used, five of them fastened to a ring about 75 feet from the bottom, and the five others about 25 feet below the top; these guys were connected to rings, which originally rested on brackets riveted to the tower.

These were about the conditions on the morning of October 7th, when the test was commenced. The pumps had been started, and the water column stood at a height of 227 feet in the tower, when, according to the report of those present, there was a sharp premonitory rending sound and then a crack suddenly appeared in the bottom portion of the tower, running up about 20 feet, followed by a most complete wreck of the whole lower part, and the fall of the tower in the midst of a deluge of water that tore up the ground, and endangered the lives of all present.

An inspection of the wreck shows a most wonderful rending and distortion of metal. The entire bottom or wider part of the tower is torn to pieces and large fragments of the plates were projected to a distance of 50 to 60 feet from the foundation. The plates themselves form a curious exhibit; some are bent almost double and others are actually rolled up, showing a very tough metal. On the other hand, a number of the plates are broken in a manner showing a brittle, almost glassy structure, and others again present a much serrated edge with long, dagger-like projecting points.

A very competent witness, an expert in constructive work of this nature, visited the ground immediately after the disaster, and says that at that time there was a distinct circular impress in the ground, overlapping the base somewhat, which would indicate an almost vertical fall of the upper part of the tower before it toppled over. This agrees with other statements made and the appearance of the wreckage about the base. The utter destruction of the lower parts of the tower and the appearance of the fallen tower, which is broken in two just above the cone and presents an almost clean square cut just below this cone, can be likened to nothing better in effect than the sudden smashing of the lower part of a high glass cylinder and the vertical drop and then fall of the upper part. The guys on this tower very possibly had some effect in maintaining the structure in a vertical position for a moment of time.

In summing up on the general evidence, we should say that the plates were amply thick enough to stand the stress put upon them, even were they a good wrought-iron; the workmanship seems to have been generally good, though some of the riveting was not quite up to the standard; the general design was an awkward one and we should not approve of it. But we should say that the main cause of failure lay in the presence of defective steel plates in the lower part of the tower. These plates certainly varied very much in quality, and the wreck shows plates which could not possibly have stood any considerable test for tensile stress. Only a brittle material could have brought about the utter destruction there exhibited and it would seem as if this brittle material had unfortunately been concentrated in the portion of the tower exposed to the greatest strain.

The Gruson Armor Test at Spezia.

In connection with the presence in this country of the authorized agent of Herr Gruson, of Buckau-Magdeburg, the constructor of chilled cast-iron for sea-coast protection, it is interesting to note the results of the last trials of the Gruson armor at Spezia, in competition with the armor of other makers for introduction into the sea-coast turrets of Italy. We are particularly interested in this class of cast armor as being something that could be turned out in our own country, with less expense than the enormously costly built up and rolled armor of England. We have the material on hand to excel in cast-iron products especially, and in sea-coast defence the bulk is not objectionable.

The details of Mr. Gruson's forms of turret-castings have been illustrated several times in this journal, and we will here content ourselves with giving in general terms the results of this latest, and most severe armor test.

The trial was commenced at Spezia, Italy, on April 20, 1886; and the purpose was to test and adopt a type for the two turrets to be erected for the defence of Spezia, each turret to mount two 120-ton Krupp guns. The successful competitor was to make a shield capable of standing three blows from the projectile of a 100-ton Armstrong, breech-loading gun, and Herr Gruson submitted his armor to this test, and won under the following conditions:

The Gruson Shield used at Spezia weighed 86.56 tons, and was shaped to represent the section of a turret with exterior surface inclined at a sharp angle; and it was 49.21 inches thick at the deepest part, measured at right-angles to its surface, and 33.56 inches at the upper or thinnest part; measured vertically the height of the shield was about 10 feet. This shield was chilled white-iron on its exterior face, while the interior was mottled iron. The shield-segment was confined between cheek-pieces of iron backed by masonry, so that the conditions would be as nearly as possible as if it formed part of a finished turret 33 feet in diameter.

The 100-ton Armstrong gun was mounted off a raft, and fired at a range of 438 feet from the shield; the weight of the hollow, forged and hardened steel Krupp projectile was 2,205 pounds; the firing charge of Cologne prismatic cocoa powder was 826.7 pounds, and the striking velocity was about 1,765 feet, with a striking energy of 47,620 foot-tons.

The result of shot No. 1, under the above conditions was to break the projectile into small fragments and deflect them up-wards; the effect upon the shield was to show a shallow scoop at the point of impact, with four radiating cracks on the outside, one about ¼ inch wide and the other hair-cracks. Inside the shield one hair-crack only made its appearance.

Trial shot No. 2, was made on April 24th, with the same conditions as before, excepting that the striking velocity was 1,772 feet, and the striking energy was 47,990 foot tons; this latter would represent a perforation through iron of 31.3 inches, but cannot be applied to this hard target which must be broken and not perforated. As before, the Krupp steel projectile broke in fragments, the largest piece found weighing 56 pounds. The shield was struck about 3 feet distant from the first shot-mark; a more serious indentation was made, being 4 instead of 2 inches deep, and a number of cracks were formed on the face, some opened as wide as 1¼ inches; while on the back of the shield three fine cracks appeared.

The third round was fired April 29th, with same general conditions, with 1758.9 feet striking velocity, and 47,306 foot-tons striking energy. The mean pressure in the bore was 13.11 tons per square inch. The third shot struck again within about 3 feet of round No. 1; the projectile flew into apparently smaller pieces than before, and, although a portion of the plate was actually cracked loose so that it could be removed, the shield appeared not only in condition to receive another blow, but was thought by Herr Gruson to be more firmly supported than before; for the masonry and cement backing had failed somewhat under the first two blows, and a slight space had opened behind the edge of the plate on either side.

The general result of the three shots was that a detachment of men could have remained behind the shield unharmed during the trial, and that the few small pieces detached from the inside seemed rather to have been shaken off than to have been projected with violence as in the case of a bolt-head. The trial was remarkable for its severity as no ship could have delivered three such shots at similar range in actual combat. English authorities admit that either of these three projectile would have gone clean through almost any armor possessed by them on ships or fort.

The Late Yacht Races.

The seventh contest for the possession of The "America Cup" which was won from the Royal Yacht Club at Cowes in 1851, was concluded on the evening of Sept. 11th, by a defeat of the Galatea which was almost painful in its completeness.

As it was complained that the Galatea had not met with "cutter weather" that is, a high wind with a lumpy sea, an adjournment was had to Newport when an unsatisfactory race was sailed with the advantage to the Mayflower, and from that place the yachts went to Marblehead, where they waited over a week for a wind that should prove satisfactory to the Galatea, without finding it.

The superiority of American models was further shown by a race between the schooner yachts, Sachem, (modelled by Burgess, the designer of the Puritan and Mayflower) and the Miranda, a famous English cup winner, brought over here this summer, in which the Miranda was beaten, and the result of five races between the single stick, Thetis and Stranger, out of which the Stranger (English) won only two, having been outsailed whenever there was a breeze. This gives English models a score of two in nine races this season.

The cup won by Commodore Stevens at Cowes, was given in trust to the New York Yacht Club as an International challenge cup, and the following contests have been made for its possession:

1851—At Cowes "America" against the Royal Yacht Club
1870—At New York the Magic against the Cambria.
1871—At New York the Columbia & Sappho against the Livonia.
1876—At New York the Madeline against the Countess of Dufferin.
1881—At New York the Mischief against the Atalanta.
1885—At New York the Puritan against the Genesta.
1886—At New York the Mayflower against the Galatea.

The two last results in connection with the outside races mentioned above are particularly gratifying, as England, which now has but two industries left in which she is eminent, viz.: pig iron and her merchant marine, has been unsparing in her efforts to convince us that our skill in maritime architecture was a thing of the past and that our genius lay in developing our supply of cheap wheat for her markets, while she developed the Indian supply, and we either continued to pay her over $100,000,000 freight money annually or else rigorously bought all our ships from her.

Unfortunately for her yacht owners and general reputation, she succeeded in convincing herself; and as there was no chance for Government interference in the matter of models, we have relied on native talent, and the cup stays here and is likely to stay. We have four yachts, three of which could undoubtedly and probably all four of which could keep the trophy here against any thing she can send for it. Added to this is a growing conviction on the part of all but the most thorough going Anglomaniacs among us that while we are so far ahead in the matter of pumps, bridges, engines and marine architecture, nothing but culpable ignorance or something worse could have influenced the decision to buy plans for our war-ships from England.

The Influence of Ground-Water on Health.

We make the following abstract of a paper with the above title lately read before the Congress of the Sanitary Institute, at York, England, by Latham Baldwin, C. E:—

Mr. Baldwin commenced by saying that it is curious to note in this connection that Hippocrates, 2,000 years ago, recorded conditions attending healthy and unhealthy seasons which are identical with conditions which may be observed in England to-day. Hippocrates taught that all disease may be traced to natural causes, and he counted it impiety to maintain that any one more than another is an infliction of the Divinity; he pointed out to his followers that to study medicine properly, they must first study the seasons and their effects; and he also stated that acute diseases occur in periods of draught. This ancient writer went much further than the authorities of our own time, in so much that he predicted the changes in the seasons by the rising and the setting of the stars, etc.

Mr. Baldwin notes as curious that a dry winter is often the precursor of disease, not at that time, but in the following autumn. As a rule a short supply of rain in December has a most marked influence upon the store of underground-water, and a lack of rain in this month has probably a greater influence upon the future health of any particular district than it has in any other month of the year. Dr. Laycock has published an interesting account showing the incidence of disease in York, and the reccurrence of local sanitary conditions during the prevalence of the sweating sickness of 1550-51, the plague of 1604, the cholera of 1832 and the typhoid fever of 1884.

The result of Mr. Baldwin's prolonged observations on the subject of ground-water in England has convinced him that there is generally a direct parallelism between the conditions of health and the volume of ground-water, The years with the largest quantity of underground-water have been invariably the healthiest years and vice versa.

As a rule the lowness of the ground-water indicates not the present but the future state of health; the unhealthy season following the low water level. In cases where the unhealthy period occurs with the lowness of the water level, there is clear evidence that percolation has commenced before the unhealthy period takes place. These results are entirely confirmed by observations made in Paris between 1868 and 1883, collated and published by M. Durand Claye, Chief Engineer of the Municipality of Paris.

The observations of Professor Pettenkofer, commenced in 1854, differ from English experience by showing that typhoid fever in Munich commenced with the fall of the subsoil water, and reached its greatest degree of intensity with the greatest degree of lowness;

and that the fever diminished with the rise in level. This is exactly the reverse of English experience, except that the greatest intensity of fever coincides with the lowest water level, and that the years of lowest water are the years in which there is most fever.

In England there is clear evidence that the lowering of subsoil water by artificial means will, and does produce, a tendency to the development and dissemination of typhoid fever. This effect is noted in drainage work connected with construction; and in sewer work it is often charged to sewer gas, etc., even in cases where no connection with the sewers has been made at the time of the outbreak.

In 1866, in East London, when there was an outbreak of cholera, the evidence showed that in the district most effected, the subsoil water was unduly lowered in the construction of the main drainage works in that part of London. On the completion of this work, and the proper working of the sewers, the epidemic terminated.

Mr. Baldwin notes that in recent times, as a rule, there has been every ten years a marked period of low water; for example, in 1834-5, 1844-5, 1854-5, 1864-5, 1874-5, 1884-5. The lowest water in this period was probably in 1864-5.

The register of Croydon, where Mr. Baldwin has been making extended observations, goes back to 1559, and with the exception of years in which it has been disturbed by revolution, etc., is very complete. The tabulation of the burials and baptisms at this point clearly indicate that years of drought are, without exception, the most unhealthy periods.

The author deduces from his experience the fact that ground-water in itself has no influence, for good or evil, upon health; but that its lowness or highness is an index of conditions which greatly influence the health of all communities.

Professor Pettenkofer has shown that ground-water may be chemically more impure in periods of high water when the conditions were favorable to health than where there is a low state of water and a condition unfavorable to health. And the records also show that we have periods when rain has started in existence malignant diseases; while on the other hand, we have similar heavy rainfalls accompanied by a high state of health.

The records clearly point out that there are at least two or three factors necessary for the production and distribution of disease, viz: 1. The elements which produce disease, such as a polluted state of the ground. 2. The conditions which are necessary for the development of disease, such as a period of dryness of the ground in those regions which water usually occupies, combined with a comparatively high temperature. 3. Conditions which will lead to the spread of the disease, such as the probable effect of a storm or rain in driving impurities out of the ground into our water supply, or through the instrumentality of ground-air passing into our habitations, and its reception by a population which is in a condition to receive such germs of disease. If any one of these conditions is absent, typhoid diseases do not occur.

With all this we must not lose sight of other conditions which are also at work. The influence of light is the first to consider. It will be observed that with reference to the period of percolation that it is almost parallel with the time the sun is below the horizon. This is well known in malarious countries which while safe in the day-time, become dangerous after night-fall. The influence of temperature is another factor; there is no doubt that, in winter time, many diseases are aggravated by the intensity of cold, but cold is not essential to the promotion of disease, especially in children under five years of age. This is shown by Dr. Farr, who points out that the death-rate of children is lower in Norway than in England, and in England less than in Italy.

Mr. Baldwin is of the opinion that the proper method by which to estimate the sanitary state of any district, is to take the number of children under five years of age and calculate the deaths by the number living at these ages. Figures show, especially after deducting the deaths from diarrhœa, which are influenced by high temperatures, that there is an almost exact parallelism between the periods of percolation and that of deaths occurring at these ages; the smallest number of children dying in the month of June, and the largest number in December and January. Then too, the death-rate fluctuates from year to year in a marked manner with the fluctuations of the ground-water.

The fluctuation of the water-line is an essential condition in the development of disease, especially typhoid fever and cholera. Professor Pettenkofer points out that in those districts where the rivers are held up at uniform levels by weirs, the conditions are favorable to health, and in them cholera rarely becomes epidemic. This doctrine is upheld by the state of health at sea-side resorts in England. And in the town of York, previous to the construction of the lock at Naborn the tide used to flow up to that city and cause vaying water levels; since the construction of this lock the health of York has materially improved. In districts occupied by a number of mills with dams maintaining a uniform water level, the same good conditions are observed as a rule.

In conclusion, Mr. Baldwin says it is clear that sewers may be of great advantage in maintaining uniformity in the water-level, while leaky sewers, on the other hand, not only pollute the soil but may cause considerably greater variation in the levels of underground water than would otherwise occur. Good land drainage has a tendency to produce uniformity of water-level; but this should rarely be attempted through sewers carrying polluted matter. Every precaution should be taken against polluting the ground, and above all sewers should be water-tight absolutely. Burial-grounds too, in position influencing underground waters, have a baneful effect on health. And finally, *no* supply of water for dietetic purposes should be taken from wells sunk in the immediate subsoil in populous places, and our houses should be so constructed as to exclude all ground-air.

Steam for Engine Use.

It pays to superheat steam, to be used in engines, some 100° Fahr. By superheating is meant giving to the steam a temperature in excess of the normal temperature corresponding to saturated steam at a given pressure. If dry steam is superheated, heat can be given out to the colder sides of the cylinder and piston of the engine, when the superheated steam enters the cylinder, without condensation taking place, or at least reducing it to a very small quantity.

If saturated (dry), or initially wet, steam is let into the cylinder, considerable condensation takes place at once (the interior surface of cylinder being at the much lower temperature of the exhaust steam), and increases rapidly during expansion, heat being later abstracted from the sides of the cylinder and piston for re-evaporation of the condensed steam (or water) during exhaust. All heat so abstracted, due to presence of water in cylinder (resulting from initial moisture in steam, initial condensation of the entering steam, and further condensation during expansion) represents absolute waste. The heat lost in this way represents a large quantity, increasing with the initial moisture in the steam and with the ratio of expansion used, and in good engines amounts to some twenty to fifty per cent. of the heat energy initially in the steam.

If the steam could be superheated considerably more than 100° Fahr., it would theoretically prove an advantage, but practically so high a temperature would then be reached as to burn the lubricating material and destroy the engine within a short time. But the use of steam superheated 100° Fahr. is entirely feasible, and uninjurious to engines, and, as has been definitely proved by Mr. Dixwell in the far-famed experiments at the Massachusetts Institute of Technology, materially adds to the economy of steam engines, by reducing a great portion of the waste ordinarily due to the presence of a large amount of moisture in the cylinder. It is surprising that the use of superheated steam for engine purposes is not more extended than it is. Of course separate superheaters, apart from the boilers, can alone successfully accomplish the result.

It pays to use high initial steam pressure for engine purposes. The back pressure due to exhaust steam is practically about the same in any given engine, whatever the initial steam pressure, and certainly does not increase proportionately with the initial pressure. The result is that if the same ratio of expansion is used in both cases, the loss of power due to back pressure forms a smaller percentage of the total power developed in a given engine, when the initial pressure is high than when it is low.

So if high initial pressure is employed, more useful power can be secured out of a given steam plant, and consequently the expense per horse power per hour is less than when the initial steam pressure is low. Or if only the same power is obtained in both cases for a given steam plant, a higher ratio of expansion can be used to secure the same effective and mean effective pressure in cylinder (corresponding to the desired horse-power) when the higher initial steam pressure is employed, and consequently the steam and fuel consumption will be less—again showing the expense account in favor of the higher initial steam pressure.

The main practical limits to the use of high steam pressure are considerations relating to the safety of boiler, but there is constant progress in the securing of strength of steam generators. When the use of exceedingly high steam pressures is under contemplation, the practical difficulty relating to destruction of lubricants and engine, consequent upon the high temperatures corresponding to such pressures, must be taken into account. But in stationary engine practice, the steam pressures under advisement have not yet reached within the domain of making such consideration a practical necessity.

The Aqueduct Commission

At the stated meeting of the New Croton Aqueduct Commission, on October 6th, the estimated expenditure of the Commission for the year 1887, was put down at $5,000,000. The Committee of Construction recommended the sinking of an additional shaft, between Shafts 13 and 14, as necessary for the proper ventilation and prosecution of the work; action was also taken in connection with the securing of ground for a new shaft known as Shaft 15½, previously authorized. The report of the President of the Commission, called for by a resolution of May 26th, last, and which

was to include plans and work of construction to June 1, 1886, having been delayed by reason of the amount and class of labor involved, the date of this report has been changed to cover the year 1886, and it is now in active preparation.

Fast Railroad Speed.

During the recent fire at Salisbury, Md., on the night of October 17, the fire department of Wilmington, Del., volunteered its services and was sent to the site of the conflagration by a special train on the Delaware Division of the Philadelphia, Wilmington & Baltimore R. R. This road is now operated by the Pennsylvania R. R. Co., and the distance to Salisbury of 103 miles was made in 102 minutes.

This exceeds in distance but not in speed the fast run made on the West Shore R. R., on July 9, of last year. The fastest time then made was 60.9 miles in 56 minutes, or a rate of 65¼ miles per hour, and thirty-six miles run at an average speed of 72.6 miles an hour.

One Week's Refuse Matter, in New York.

The report of the Department of Street Cleaning of the City of New York, shows that in the week ending October 10, 1886, the following quantity of material was gathered and disposed of:

Ashes	13,626	loads.
Street-dirt	6,061	"
From Department of Public Works	228	"
" Markets	151	"
" Permits	3,398	"
Total	23,464	

Over 20,000 loads of the above were carried out to sea in dump scows and there disposed of.

The Corinth Canal.

Le Canal de Corinthe, for September 30, 1886, says that the work on the Corinth Canal is actively progressing. During August 161,000 cubic metres of material were moved, not counting the work done by dredges in re-handling this material. The September work was delayed somewhat by reason of a violent earthquake on August 27, and its after disturbances. The earthquake, however, did little or no harm to the canal works. An unexpected slip of a mass of earth, 150 by 200 metres, shut up the mouth of one of the tunnels, and imprisoned four workmen only one of whom was recovered alive. Gen. Turr, the President of the Council of Administration, and M. Bazaine, the ChiefEngineer, were then at Corinth making their annual inspection of the works.

The Drainage of Lake Copais.

Among the engineering enterprises of today, one little noted, but of considerable interest and importance, is the drainage of Lake Copais, near Thebes in Greece, now being carried out under the direction of French engineers.

This lake is about twelve miles north of the City of Thebes and is separated from the sea by a low chain of hills; its water surface is equal to about 62,500 acres, or nearly ninety-eight square miles. The bed of the lake is almost flat and is about 327 feet above the sea-level.

As evidenced by shafts and other abandoned engineering works, the Greeks, ages ago, actually commenced operations in an attempt to drain this lake. After a series of later attempts to organize a company for this purpose, a M. Vouro, in 1889, obtained a new concession and M. Leon Pochet, his engineer submitted the following project:

M. Pochet proposed both to drain the lake and to arrange a system of irrigation canals for the after service of the drained area; the latter scheme being carried out by a series of canals intercepting the tributary streams.

The drainage of the lake proper is accomplished by leading the various lines of drainage canals to a common outlet near Karditza, and thence by a tunnel passing the summit lying between Lake Copais and Lake Hylicus. Another canal conveys the water to Lake Paralimni, and finally by a tunnel through the hills near Anthedon to the Straits of Negrepont. The estimated cost of this vast drainage scheme is not stated.

PERSONAL

The managers of the Bennington Battle Monument Association, at Troy, N. Y., have decided to have the structure, which will be 300 feet high, erected under the supervision of a consulting engineer: the architect concurs in the decision.

JOHN F. WALLACE, M. Am. Soc. C. E., who has been engaged on the Central Iowa R. R. as Resident Engineer, is now employed on the Union Pacific R. R. at Fort Steel, Wy. Ter., as Assistant Engineer

PHILIP DINKELBERG, contractor, of Lancaster, Pa., died October 14.

FERNANDO WOOD, Superintendent of the water-works at Croton Dam, N. Y., for twelve years, has resigned his position. MR. WOOD has made the water supply of New York a study and is the author of a pamphlet entitled "The Water supply of New York City, Past and Present, 1658 to 1883," printed for private circulation only. His successor will probably be JOHN OWEN SOMERS, N. Y.

A dispatch to the Brooklyn *Eagle* states that the Grand Jury has found that CITY ENGINEER KRAUSE, of Buffalo, has been negligent in the discharge of his duties and was incompetent to superintend his department. CHARLES STEINWACH, a contractor who has been doing work for the city, has been indicted for grand larceny in making excessive charges; he pleaded not guilty.

ALEXANDER AGASSIZ, President, and E. D. LEAVITT, JR., Consulting Engineer, of the Calumet & Hecla Mining Company, are still in the Lake District. It is supposed that they are considering some extensive modifications and changes in the mine plant that have been contemplated for some time. Low prices are reducing the cost of production at the Calumet & Hecla.

IRVING A. STEARNS, the General Manager of the Pennsylvania Railroad Company's coal mining interests, though a young man, is a mining engineer of great experience and of deservedly high reputation. The Pennsylvania Railroad Company exhibited in his appointment its proverbial sagacity, to which it owes the well-earned reputation of being technically the best managed road in the world. Now, no mines in Pennsylvania, which is equivalent to saying no mines in the world, are better or more economically managed than those of the Susquehanna Coal and the other companies controlled by the Pennsylvania Railroad Company under the direction of MR. STEARNS.

BRIG. GEN. JAMES C. DUANE was last week appointed by the President to succeed Gen. John Newton, lately retired, as Chief of Engineers, U. S. A. GEN. DUANE was third in rank among the Colonels of the Engineer Corps, but both of his seniors await their retirement for age, that of Col. Blunt occurring this coming winter and that of Col. Stewart is due next April. GEN. DUANE is a native of New York and was appointed to the U. S. Military Academy from that State on July 1, 1844. He graduated from the Academy as 2nd. Lieut. of Engineers in 1848; was promoted to Captain of Engineers, August 6, 1861; Major, March 3, 1863: Lieut. Col., March 7, 1867, and Colonel of Engineers, January 10, 1883. During the Civil War GEN. DUANE was in continuous active service, and was breveted Colonel on July 6, 1864, for meritorous services in the campaign from the Rapidan to the James, and particularly for his services before Petersburg, Va. On March 13, 1865, he was breveted Brig. Gen. for gallant work at Petersburg and in the general campaign ending in the surender of General Lee. For some years past GEN. DUANE has been in charge of the Third Light-house District, with headquarters at Tompkinsville, on Staten Island.

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American Society of Civil Engineers.

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Mr. Chas. E. Emery then read a short paper on a machine for drawing sheet-piling; devised by him for use in the trenches of the New York Steam Heating Co. It was simply a heavy U-shaped clamp with sharp edges and an opening slightly wider than the plank to be drawn; on one side of this clamp was an eye to which were attached several stout links. A long wooden lever with an iron hook at one end and a stout trestle to act as a fulcrum, completed the outfit. In action the clamp was tilted slightly by any lifting effort on the bar and the sharp edges cut into the wood and gave the clamp a firm grip, upon lowering the point of the lever the clamp slid down by its own weight ready for another grip. The device is simple and has proved very efficient in action.

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and that the fever diminished with the rise in level. This is exactly the reverse of English experience, except that the greatest intensity of fever coincides with the lowest water level, and that the years of lowest water are the years in which there is most fever.

In England there is clear evidence that the lowering of subsoil water by artificial means will, and does produce, a tendency to the development and dissemination of typhoid fever. This effect is noted in drainage work connected with construction; and in sewer work it is often charged to sewer gas, etc., even in cases where no connection with the sewers has been made at the time of the outbreak.

In 1866, in East London, when there was an outbreak of cholera, the evidence showed that in the district most effected, the subsoil water was unduly lowered in the construction of the main drainage works in that part of London. On the completion of this work, and the proper working of the sewers, the epidemic terminated.

Mr. Baldwin notes that in recent times, as a rule, there has been every ten years a marked period of low water; for example, in 1834-5, 1844-5, 1854-5, 1864-5, 1874-5, 1884-5. The lowest water in this period was probably in 1864-5.

The register of Croydon, where Mr. Baldwin has been making extended observations, goes back to 1559, and with the exception of years in which it has been disturbed by revolution, etc., is very complete. The tabulation of the burials and baptisms at this point clearly indicate that years of drought are, without exception, the most unhealthy periods.

The author deduces from his experience the fact that ground-water in itself has no influence, for good or evil, upon health; but that its lowness or highness is an index of conditions which greatly influence the health of all communities.

Professor Pettenkofer has shown that ground-water may be chemically more impure in periods of high water when the conditions were favorable to health than where there is a low state of water and a condition unfavorable to health. And the records also show that we have periods when rain has started in existence malignant diseases; while on the other hand, we have similar heavy rainfalls accompanied by a high state of health.

The records clearly point out that there are at least two or three factors necessary for the production and distribution of disease, viz: 1. The elements which produce disease, such as a polluted state of the ground. 2. The conditions which are necessary for the development of disease, such as a period of dryness of the ground in those regions which water usually occupies, combined with a comparatively high temperature. 3. Conditions which will lead to the spread of the disease, such as the probable effect of a storm or rain in driving impurities out of the ground into our water supply, or through the instrumentality of ground-air passing into our habitations, and its reception by a population which is in a condition to receive such germs of disease. If any one of these conditions is absent, typhoid diseases do not occur.

With all this we must not lose sight of other conditions which are also at work. The influence of light is the first to consider. It will be observed that with reference to the period of percolation that it is almost parallel with the time the sun is below the horizon. This is well known in malarious countries which while safe in the day-time, become dangerous after night-fall. The influence of temperature is another factor; there is no doubt that, in winter time, many diseases are aggravated by the intensity of cold, but cold is not essential to the promotion of disease, especially in children under five years of age. This is shown by Dr. Farr, who points out that the death-rate of children is lower in Norway than in England, and in England less than in Italy.

Mr. Baldwin is of the opinion that the proper method by which to estimate the sanitary state of any district, is to take the number of children under five years of age and calculate the deaths by the number living at these ages. Figures show, especially after deducting the deaths from diarrhœa, which are influenced by high temperatures, that there is an almost exact parallelism between the periods of percolation and that of deaths occurring at these ages; the smallest number of children dying in the month of June, and the largest number in December and January. Then too, the death-rate fluctuates from year to year in a marked manner with the fluctuations of the ground-water.

The fluctuation of the water-line is an essential condition in the development of disease, especially typhoid fever and cholera. Professor Pettenkofer points out that in those districts where the rivers are held up at uniform levels by weirs, the conditions are favorable to health, and in ther
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Steam for Engine Use.

It pays to superheat steam, to be used in engines, some 100° Fahr. By superheating is meant giving to the steam a temperature in excess of the normal temperature corresponding to saturated steam at a given pressure. If dry steam is superheated, heat can be given out to the colder sides of the cylinder and piston of the engine, when the superheated steam enters the cylinder, without condensation taking place, or at least reducing it to a very small quantity.

If saturated (dry), or initially wet, steam is let into the cylinder, considerable condensation takes place at once (the interior surface of cylinder being at the much lower temperature of the exhaust steam), and increases rapidly during expansion, heat being later abstracted from the sides of the cylinder and piston for re-evaporation of the condensed steam (or water) during exhaust. All heat so abstracted, due to presence of water in cylinder (resulting from initial moisture in steam, initial condensation of the entering steam, and further condensation during expansion) represents absolute waste. The heat lost in this way represents a large quantity, increasing with the initial moisture in the steam and with the ratio of expansion used, and in good engines amounts to some twenty to fifty per cent. of the heat energy initially in the steam.

If the steam could be superheated considerably more than 100° Fahr., it would theoretically prove an advantage, but practically so high a temperature would then be reached as to burn the lubricating material and destroy the engine within a short time. But the use of steam superheated 100° Fahr. is entirely feasible, and uninjurious to engines, and, as has been definitely proved by Mr. Dixwell in the far-famed experiments at the Massachusetts Institute of Technology, materially adds to the economy of steam engines, by reducing a great portion of the waste ordinarily due to the presence of a large amount of moisture in the cylinder. It is surprising that the use of superheated steam for engine purposes is not more extended than it is. Of course separate superheaters, apart from the boilers, can alone successfully

steam pressures is under contemplation, the practical difficulty relating to destruction of lubricants and engine, consequent upon the high temperatures corresponding to such pressures, must be taken into account. But in stationary engine practice, the steam pressures under advisement have not yet reached within the domain of making such consideration a practical necessity.

The Aqueduct Commission

At the stated meeting of the New Croton Aqueduct Commission, on October 6th, the estimated expenditure of the Commission for the year 1887, was put down at $5,000,000. The Committee of Construction recommended the sinking of an additional shaft, between Shafts 13 and 14, as necessary for the proper ventilation and prosecution of the work; action was also taken in connection with the securing of ground for a new shaft known as Shaft 15½, previously authorized. The report of the President of the Commission, called for by a resolution of May 26th, last, and which

was to include plans and work of construction to June 1, 1886, having been delayed by reason of the amount and class of labor involved, the date of this report has been changed to cover the year 1886, and it is now in active preparation.

Fast Railroad Speed.

During the recent fire at Salisbury, Md,, on the night of October 17, the fire department of Wilmington, Del., volunteered its services and was sent to the site of the conflagration by a special train on the Delaware Division of the Philadelphia, Wilmington & Baltimore R. R. This road is now operated by the Pennsylvania R. R. Co., and the distance to Salisbury of 103 miles was made in 102 minutes.

This exceeds in distance but not in speed the fast run made on the West Shore R. R., on July 9, of last year. The fastest time then made was 60.9 miles in 56 minutes, or a rate of 65½ miles per hour, and thirty-six miles run at an average speed of 72.6 miles an hour.

[illegible] the President of the Council of Administration, and M. Bazaine, the ChiefEngineer, were then at Corinth making their annual inspection of the works.

The Drainage of Lake Copais.

Among the engineering enterprises of today, one little noted, but of considerable interest and importance, is the drainage of Lake Copais, near Thebes in Greece, now being carried out under the direction of French engineers.

This lake is about twelve miles north of the City of Thebes and is separated from the sea by a low chain of hills; its water surface is equal to about 62,500 acres, or nearly ninety-eight square miles. The bed of the lake is almost flat and is about 327 feet above the sea-level.

As evidenced by shafts and other abandoned engineering works, the Greeks, ages ago, actually commenced operations in an attempt to drain this lake. After a series of later attempts to organize a company for this purpose, a M. Vouro, in 1880, obtained a new concession and M. Leon Pochet, his engineer submitted the following project:

M. Pochet proposed both to drain the lake and to arrange a system of irrigation canals for the after service of the drained area; the latter scheme being carried out by a series of canals intercepting the tributary streams.

The drainage of the lake proper is accomplished by leading the various lines of drainage canals to a common outlet near Karditza, and thence by a tunnel passing the summit lying between Lake Copais and Lake Hylicus. Another canal conveys the water to Lake Paralimni, and finally by a tunnel through the hills near Antiedon to the Straits of Negrepont. The estimated cost of this vast drainage scheme is not stated.

PERSONAL

The managers of the Bennington Battle Monument Association, at Troy, N. Y., have decided to have the structure, which will be 300 feet high, erected under the supervision of a consulting engineer; the architect concurs in the decision.

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In answer to a question by the Vice-President as to the loss of steam on its way to the consumer, Mr. Emery answered as follows: The present supply of steam from the main

station on Greenwich Street, was about 8,000 horse-power daily in the winter months, and from 3,500 to 4,000 horse-power in summer, though the maximum capacity of the works was 16,000 horse-power. It has been ascertained by careful tests that the average loss from condensation in the mains, is equivalent to about 200 horse-power daily. But in spite of the most carefully made joints and special devices to overcome the effects of contraction and expansion, there was a loss due to leakage of about 600 horse-power. It is found, however, that the mains themselves are not injured by this escape of steam, and they are practically as good to-day, after a year or more of use, as when laid.

With regard to loss of pressure between the the works and the point of delivery to the consumer, Mr. Emery said that the distribution system was originally designed on a basis of a loss of 10 pounds for each half-mile of circuit. But in practice, larger pipes were actually used, and the ascertained difference in pressure between the boilers and a point ½-mile away, has rarely exceeded 2 pounds, and is never expected to reach the estimated 10 pounds. In testing this difference of pressure by applying gauges simultaneously to the mains at various points, the officials were somewhat surprised to find records of pressure at distant points of the mains, showing pressures 2 pounds in excess of the boiler pressure at the same moment. Mr. Emery explained this anomalous condition of things by the rather slow motion of the steam current in the pipes, and that considerable time would really elapse before the remote mains could respond to the immediate boiler pressure, the pressure found being really the result of previous higher boiler pressure. As an interesting point it was remarked that at from 40 to 50 cents per 1,000 Kals, the present price to consumers, one ton of water was conveyed a distance of half a mile to consumers, in the shape of steam, cheaper than the same ton of water could be carted or delivered in any other way in the city of New York.

The meeting was closed by the reading, by the Secretary, of an interesting letter from Mr. H. A. Duc, of Charleston, N. C., detailing some earthquake experiences, and illustrated by photographs and numerous specimens of ejected sand and mud and of the brick and mortar from the ruined city.

Engineers' Club of Philadhlphia.

RECORD OF REGULAR MEETING. October 2d, 1886.

President Washington Jones in the chair; 31 members and 1 visitor present.

Prof. L. M. Haupt read some extracts from a paper by Mr. Milne, Institution of Civil Engineers, entitled, "Construction in Earthquake Countries," with its discussion. The results were obtained from careful seismic surveys made in Japan, and led the author to state that the safety or a building depended primarily upon its inertia, and secondarily upon its foundation being made "free," either by using a bearing of cast-iron shot, or of troughs filled with sand. A peculiar phase of earthquake phenomena not hitherto observed was the much greater disturbance at the surface of the ground over that at the bottom of a pit only ten feet deep. As to the site of a building, solid and high ground was always to be preferred.

Prof. Haupt also exhibited some photographs of Mr. J. Lesley Corbett's Improvements in Solar, Mining and Engineers' Transits, which he has so ably adapted to meet the numerous and complicated requirements of the various sub-divisions of the profession. This instrument, which is at once stadia, graduator, transit, alt-azimuth, solar and level, was made by the Messrs. W. & L. E. Gurley Troy, N. Y., in 1883-4.

Mr. Oliver B. Harden read a paper upon the Reduction of Maps by Photography — the method employed by the 2d Geological Survey of Penna., on account of its accuracy, quickness and cheapness as compared with other methods of reduction.

He described the character of the maps so reduced and their scales, exhibiting reductions of mine maps, the alignment map of the Pottsville and Mahanoy Railroad, and the maps of the Philadephia Water Department Survey, calling attention to the excellent character of the prints made by Messrs. Julius Bien & Co. of New York.

He said the only element of error was the contraction of the sensitive paper, which, however, was provided for in reduction. There is no error due to distortion by the lens. The accuracy of reduction depends in a great measure on lining the camera at right angles to the map.

This method of reduction shows a saving of 40 per cent. over other methods when a proof copy only is needed, or, where the map is wanted on tracing paper, about 30 per cent.

The Secretary presented for Mr. John Graham, Jr., an illustrated description of the horizontal turbine at Willimantic. The object of the horizontal arrangement were to avoid complication of gearing and loss by friction from weight and pressure on step, and to attain greater power from available head of water Two sets of turbines each, operating two pumps, are placed upon connected horizontal shafts, revolving in cast iron casings to which the water is admitted through the iron inlets six (6) feet in diameter.

The special features of this turbine arrangement are as follows. Two (2) movable or revolving wheels,—the blades of which are bronze,—forty-four inches in diameter are secured to a horizontal shaft placed nine (9) feet above the tail water or lower level. They are made to turn to the right and left, but placed in such a manner in relation to each other as to cause the shaft to revolve by the action of both turbines. The mechanical arrangement is such as to admit, by simply removing six coupling bolts, of operating the pumping machinery with one turbine.

In this case the end thrust caused by the want of counter action of the second turbine is taken up by glass discs surrounded with oil.

Another feature is the mode adopted for controlling the action of the water by means of sliding gates placed in front of the guide wheels.

In looking over records of Jonval turbines constructed, with the exception of "Geyelin's Duplex Jonval Turbines," it will be found that the gates heretofore used were placed below the turbines, very often at the outlet of the draft tubes, requiring, for proper construction, a foundation-plate resting upon a planked floor.

The advantages claimed for these sliding gates, controlling the *inlet* of the water instead of the *outlet*, are: First, the greater simplicity of the construction of the wheel-pit, requiring no planked floor,—often very expensive to place, owing to the presence of water.

Second. A more economical action of the water when contraction becomes necessary in the flow through the turbine, caused by either want of water or want of sufficient resistance in the machinery to be propelled.

Third. Greater simplicity in construction—consequently, greater reduction of cost.

The speed of the turbine shaft when operated under nineteen (19) feet fall, is one hundred and five (105) revolutions per minute.

The motion of the turbine can, by the shifting of a pinion, be transmitted to either set of pumps.

The general arrangement of the Willimantic plant was given by Mr. J. T. Fanning, H. E., and constructed and put in operation by the Camden Iron Works, from plans furnished by Mr. E. Geyelin, whose work is so well known in this country.

The Secretary presented, for Mr. W. E. Hall, a Review of the Freight Brake Trials.

The advantages to be derived from the use of a good, efficient frieght brake are evident, but the necessity of having uniformity in freight equipment renders the question a particularly important one, and the advisability of thorough test of the several systems before any one is adopted. The results of the first part of the trial by the Master Car Builders' Association Committee have thrown some light upon the subject.

The systems of brakes there represented were:

The direct buffer (American and Rote).
The friction buffer (Widdifield and Button).
The continuous Eames Automtic Vacuum. Westinghouse Autamatic Pressure.

The general tests consisted of stopping trains of twenty-five (25) and fifty (50) cars respectively—empty, mixed and loaded—on level, and on grade of fifty-six feet to the mile, from speeds of twenty (20), thirty (30), and forty (40) miles per hour, and of a graduating test on grade, the speed of train to be kept as near as possible to fifteen (15) miles per hour. The results show that any form of the buffer brake represented was not practicable on long freight trains, nor could they safely regulate the speed of a long train on a grade of the previously mentioned magnitude. When riding on the short trains the peculiar action of the buffer brakes is not so noticeable, but an inspection of a brake beam stress diagram will show that during a stop the brakes are alternately applied and released, causing shocks of more or less violence in the train. The buffer brakes are not automatic. The two continuous brakes were the only ones which met the requirements of good railroad practice to any extent; but with these the common defect found was that with long trains the application of the brakes at the rear was not sufficiently rapid; that is to say, the application should take place simultaneously on all the wheels of the train, and when this is not the case, violent and, indeed dangerous shocks will result. It was found that by taking out the coupling-link slack by iron wedges the violence of the shocks was much reduced. This brought forward the coupler question and it was shown that the slack in the link, at least, had no influence in the load that could be started by an engine. In the test of the automatic feature, there is still a question as to the cause of the behavior of the Eames brake in the first stop. Altogether, we do not think either of the continuous brakes have met the requirements for long freight trains to the extent desired, nor will do so until the application of the brakes can be made simultaneous on all the wheels of the train. The service is much benefitted, however, by the use—when and where admissible—of a number of cars equipped with a continuous brake next to the engine.

HOWARD MURPHY,
Secretary and Treasurer.

STAND PIPE BLOWN DOWN.—The new water tower at Kankakee, Ill., was blown down October 14 by a furious gale. The tower was built of boiler plate, was 125 feet high and 20 feet in diameter; its cost was $15,000.

MANCHESTER, N. H.—The new pumps built by the Davison Steam Pump Co., of Brooklyn, N. Y., have been put in place. The contract was awarded in April at about $12,500. The cylinders are 22.25 inches diameter and 24 inches stroke. They will have a daily capacity of 5,000,000 gallons and the old engine will now be put under repairs.

Municipal Engineering; Paper No. 3.*

WASHINGTON, D. C.

(*Continued from Page 246.*)

City Bridges.

There are within the limits of the District three bridges across the Potomac river, two across the Eastern branch, four across Rock creek, and two across the old canal, all of which are bridges of considerable spans. Of these, one across the Potomac, which replaced the old chain bridge, above Georgetown; the Aqueduct bridge, which brings the water supply across Rock creek and also carries a carriage-way; and one across the Eastern branch, one of iron, and together with a wooden highway bridge across the eastern branch, were all built, and are maintained by the United States. The Aqueduct bridge, which carries the Chesapeake & Ohio canal across the Potomac at Georgetown, is a wooden Howe truss, with the canal on the lower and a highway on the upper chords. This was built by the canal company, which charges a toll for all traffic passing over it. The Long Bridge, which crosses the tracks of the Pennsylvania R. R. Co., and a carriage-way on the same level, is a wooden Howe truss. It was built and is kept in repair by the railroad company. The carriage-road is free. There are three iron bridges across Rock creek and one across the old canal, which were built by the city. Also one wooden Howe truss bridge across the canal. The maintenance and repair of those built by the city are in charge of the Superintendent of Streets, under the direction of the Engineer Commissioners.

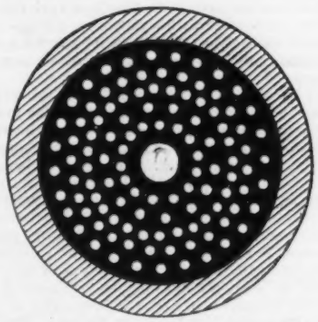

Plate 31.—Patterson Cable. Full Size.

Telegraph Wires.

The following extract from the Annual Report of Capt. F. V. Greene, Assistant to the Engineer Commissioner, for the year ending June 30, 1885, conveys about all the information to be had on this subject:

"During the past year permits were issued for 266 new poles, of which sixty-four were on the streets, 177 on the alleys and twenty-five in the county. The number of poles removed was twenty-nine, so that the net increase within the city limits was 212, nearly all of which were on the alleys. The total number of poles at this date is 2,900, with about 850 miles of wire attached to them. At the date of the last report the amount of underground lines were something over six miles, with 285 miles of wire. Since then the telephone company has added 1¼ miles of line with 574 miles of wire underground, and is now engaged in laying three more lines aggregating 2¼ miles in length, with 519 miles of wire. When these lines are completed the telephone company will have about 1,300 miles of wire underground in this city. All of the lines hitherto laid are now in successful operation. The difficulties attending the underground system are somewhat lessened by permitting the use of poles in alleys for distributing purposes. All new poles, however, whether on the streets or alleys, are erected only on a written agreement that they shall be taken down when ordered by the Commissioners, so that no vested rights to this use of the streets can be held to be acquired.

The older telegraph companies have not as yet made much progress with underground wires, but the Baltimore and Ohio company is now making plans for a line from its depot to Seventeeth street, which will remove nearly all of its poles from the central part of the city. The Western Union company made application in May last for a rearrangement of its lines, and the permit was granted on condition that about one mile should be laid underground, 2¼ miles on new poles, and 11 miles of poles should be removed entirely. This would have made a net reduction of 8¼ miles of pole lines, with over 300 poles and probably 150 miles of overhead wire. A part of the new line was to be on Seventh street, this street having been selected because it is devoted almost exclusively to business purposes and contains no trees. The property-owners on that street obtained an injunction against the erection of these poles, and the whole plan has therefore been brought to a stand-still until the question of the authority of the Commissioners to regulate this matter, which until now has never been seriously questioned, can be passed upon by the higher courts. The placing of wires underground in cities, will require a large outlay of capital, and will consume a considerable amount of time. The work can only be done gradually. More progress has been made in Washington than in any other city in the country. The policy adopted by the Commissioners and consistently carried out for the last three or four years has been to refuse permits for reconstructing pole lines within the central part of the city, and to permit extensions in the outer streets, and in alleys only, on condition that a certain amount of underground work shall be done as an equivalent. The telephone company has been most in need of extensions, and hence it has to-day the largest amount of underground wires. The electric light companies have been refused any permits except on the same terms, and they are still debating whether it will be profitable to accept them. No extensions of the electric light (except the underground line on F street) have been made in the last three years. The older telegraph companies, having their pole-lines already established, have not until now felt the necessity of asking for permits. But the rotting of poles, and the growth of trees carrying moisture into their wires, have compelled them to make a beginning, and the same causes would in a few years effect the removal of all the objectionable poles in the heart of the city, and thenceforth the placing of wires underground would keep pace with the growth of the city, providing the Commissioners retain control of the matter and pursue the same policy they have been pursuing."

The telephone company has at this time 14.6 miles of underground cable, with an aggregate of 992 miles of underground wires. They are using the Patterson cable, Plate 31, manufactured by the Western Electric Co. In this cable the wires are insulated with paraffine, and the whole encased in a lead pipe. Some of this cable has been in use here about two years, and so far has given good satisfaction.

The police and fire-alarm telegraph, and telephones are using the Waring cable, (Plate 32). They have in use about two and one-third miles of six-wire cable. This is used for both signals and alarms in the fire-alarm service and also for telephones. It has been in use over two years and gives entire satisfaction. This cable has each wire insulated and entirely surrounded with lead, so that it is a very easy matter to separate any one of the wires whenever it may be wanted.

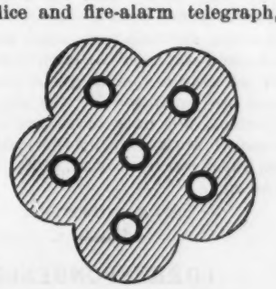

Plate 32.—Waring Cable. Full Size.

House Numbering.

On streets running north and south the numbers begin at a line drawn east and west through the center of the Capital, and runs in both directions, one number being allowed for each 20 feet front, and a full hundred for each square. Thus between East Capitol street and A street, the numbers run from 0 to 100; between A street and B street from 100 to 200. On streets running east and west the numbers run in both directions from North and South Capitol streets, in the same manner, thus between North Capitol street and 1st street the numbers run from 0 to 100; between 1st street and 2nd street from 100 to 200. It will be seen there are four houses of the same number and street located in four different quarters of the city, so that it is necessary in giving a number to designate it as N. E., S. E., S. W., or N. W., according to its location. When facing in the direction in which the numbers increase the odd numbers are on the right-hand side of the street and the even on the left-hand.

Contracts.

All public improvements which are estimated to cost more than $1,000 are required by law to be advertised not less than thirty days, and let to the lowest responsible bidder. The following instructions to bidders and proposals are those in general use in this city.

Instructions to Bidders.

1. Bidders must present satisfactory evidence that they have been for a reasonable time regularly engaged in the business, and that they are fully prepared with the necessary capital to begin and complete the work to be contracted for.

Two proposals under different names will not be received from one firm or association, and bidders will be required to specify the locality of the machinery to be used by them.

3. The Commissioners of the District of Columbia reserve the right to reject any or all bids or parts of bids which may not be deemed advantageous to the District.

4. Each bidder will be required to deposit with the Collector of the District of Columbia, to the credit of the Commissioners of the District of Columbia, the sum of five hundred dollars as a guarantee that he will enter into the contract, if awarded to him, according to the terms of his bid within five days after notification of the award. The receipt of the Collector must be enclosed with each bid. The receipts will be forwarded to the Collector after the award of the contracts, with instructions to refund the money deposited, to the unsuccessful bidders upon application, and to each contractor after the execution of the contract.

5. The written consent of the proposed sureties must accompany each proposal, and the signatures must be acknowledged before a notary public.

6. In all bids made by a firm the individual names of the members must be written out, and must be signed in full, giving the Christian names; but the signers may, if they choose, describe themselves in addition as doing a business under a given name and style as a firm.

7. The place of residence of every bidder, with county and State, must be given after his signature, which must be written in full.

8. Any one signing a proposal as the agent of another, or others, must file with it legal evidence of his authority so to do.

9. Alterations by erasures, or interlineations, should be explained or noted in the proposal, over the signature of the bidder.

10. All prices must be written, as well as expressed, in figures.

11. A failure to comply with any of the above instructions will be considered a sufficient ground for rejecting any bid, but the right is reserved to waive such defect.

12. No proposal will be received from any failing contractor, known as such on the records of the District of Columbia since July 1, 1878.

13. Proposals should be addressed to the Engineer Commissioner, District of Columbia, and endorsed "Proposals for....," in the City of Washington.

By order of the Commissioners, D. C.

Major of Engineers, U. S. A.,
Engineer Commissioner, D. C.

"PROPOSAL."

Washington, D. C.,——188

SIR:

.....hereby, propose to furnish all necessary materials (here is inserted the material furnished by the city) and labor, and in a good, firm, and substantial manner, in strict accordance with the specifications

*Copyrighted by ENGINEERING NEWS PUBLISHING Co. 1886.

and plans now on file in the Engineer Department of District of Columbia, execute the following described work, or so much thereof as may be awarded to ....., at the prices set opposite the several items, respectively, which will be accepted as payment in full for all work to be done in the proper execution of the said work:

On Boundary Street, between Fourteenth Street and Rock Creek,

Constructing sewer 3.25x4.87, inside measurement, between Fourteenth and Sixteenth streets northwest, including manholes and appurtenances.

..... ($.....) per linear foot.

Constructing sewer 3.75x5.62, inside measurement, between Sixteenth and V streets northwest, including manholes and appurtenances.

..... enclose herewith the receipt of the Collector of the District of Columbia for five hundred (500) dollars. The five hundred (500) dollars is deposited with the Collector to the credit of the Commissioners of the District of Columbia as a guarantee of good faith and to cover the cost of damage to the District in the event of .....failure to enter into a contract, with good and sufficient sureties, within five (5) days after notification of the acceptance of this proposal.

Very respectfully.

We, the undersigned, freeholders to the amount set opposite our respective names, hereby agree to become sureties for the above-named bidder or bidders in the event of the acceptance of the foregoing proposal.

_____ $
_____ $
_____ $

District of Columbia, } ss:
County of Washington, }

Personally appeared before me, a Notary Public in and for the District and County aforesaid, the above-named persons, and acknowledged the same to be their signatures.

Notary Public.

To the Engineer Commissioner of the District of Columbia.

There must be sureties to the full amount of the contract price for the work.

The time and manner of payment is fully set forth in the following:—

"GENERAL CONDITIONS."

1. All loss or damage arising out of the nature of the work to be done, or from any unforseen or unusual obstructions or difficulties which may be encountered in the prosecution of the same, or from the action of the elements, will be sustained by the contractors, who will be required, without cost to the District, to replace all pavements, etc., displaced or injured by them, and to remove from the streets all surplus material, earth, rubbish, etc., immediately after completion of the work.

2. Failure to commence the work at the time specified, or to prosecute it thereafter in a satisfactory manner and at a rate of progress necessary, in the opinion of the District Commissioners, for its entire completion within the limits of time fixed by the contract, will be authority for the said Commissioners to suspend the contractors from the work, and employ other parties to complete it. All money due the contractors at the date of suspension will be retained until the work is completed, and be applied to the payment of any increased cost thereof, and any excess of cost, over and above the amount so retained, will be charged against the contractor and sureties, who will each and severally be held liable therefor.

3. The contractor must be prepared to do any extra work that may, with the approval of the Commissioners of the District, be ordered by the Engineer Commissioner arising out of any modification in the plans or details that may appear necessary, and for this he will be paid at the contract rates for work of a similar character; or if the extra work should be of a class for which no rate is fixed by the contract, the fair price to be paid will be determined by the Engineer Commissioner, but no authority for extra work will be recognized except the written order of the Engineer Commissioner.

4. Inspectors will be appointed, whose duty it shall be to point out to the contractors any neglect or disregard of the specifications of contracts, but the right of final acceptance or condemnation of the work will not be waived at any time during its progress. Contractors will be held responsible for the faithful execution of their contracts; and upon all technical questions concerning the execution of the work, in accordance with the specifications and the measurement thereof the decision of the Engineer Commissioner of the District of Columbia shall be final. Ordinarily, one inspector will be employed by the District for each street building or other structure under contract; but if, on account of any apparent disregard of the specifications on the part of the contractor additional inspectors should be required, they will be employed by the District, at the rate of $4.00 per diem., in such numbers as, in the opinion of the Engineer Commissioner, may be necessary, and the cost of the same will be charged to the contractor.

5. All work must be commenced on or before August 1, 1883, and completed on or before December 1, 1883; if not so completed, the pay of all inspectors employed on the work after the time fixed for its completion will be charged against and deducted from any money that may be due or become due the contractor, as will also the sum of $20 per diem for the same period, estimated as liquidated and fixed damages to the District arising from failure to complete the work at the time specified—time of completion of the contract being an essential element and consideration.

6. Payments will be made monthly, upon estimates approved by the Engineer Commissioner, less ten per cent. of each estimate, to be withheld until the final payment, which will only be made upon the certificate of the said Commissioner that the work has been completed and properly executed to the satisfaction of a majority of the Board of Commissioners; but ten per centum of the cost of all new work will be retained and invested as hereinafter provided.

7. Good and sufficient bonds to the United States in a penal sum equal to the estimated amount of the contract, with sureties to be approved by the Commissioners of the District of Columbia, will be required from all contractors guaranteeing that their contract will be strictly and faithfully performed to the satisfaction of and acceptance by said Commissioners; and that the contractors will keep new pavements or other new works in repair for a term of five years from the date of the completion of their contracts; and from that date ten per centum of the cost of all new works will be retained as an additional security and a guarantee fund to keep the same in repair for said term, which said per centum will be invested in registered bonds of the United States or of the District of Columbia, and the interest thereon paid to said contractors.

8. Contractors will punctually pay the workmen who shall be employed by them upon the work under their contract, in cash current, and not in what is denominated store-pay or orders, and will, from time to time, and as often as may be required by the Commissioners of the District of Columbia, furnish to said Commissioners satisfactory evidence that all persons who have done work or furnished materials have been paid as herein required. And if such evidence is not furnished such sum or sums as may be necessary for such payment, may, in the discretion of the said Commissioners, be retained until such claims shall be fully satisfied.

9. No contract or any interest therein shall be transferred by the parties to whom the award is made. It is a condition of all contracts that such transfers will be null and void, and will cause the contract to be annulled and the work to be given to other parties under the conditions mentioned in paragraph 2 of these General Conditions.

In the monthly measurement the assistant engineer only returns 90 per cent. of the amount of work done, and only 90 per cent. of the contract price for this amount is paid. On a final measurement 90 per cent. of the entire amount of the contract is paid, the remaining 10 per cent. being held for five years as a guarantee of the work as per contract.

On sewer work all terra-cotta pipe, junction blocks, and trap rock for inverts, and on street work, all granite blocks, gutter flags and curb stones are furnished by the city. On final settlement, not only is 10 per cent. of the amount of work done by the contractor held back, but 10 per cent. of all material furnished by the city.

(TO BE CONTINUED).

CORRESPONDENCE.

Earthwork Computations.

LENA, CUSTER CO. NEB., October 4, 1886.

EDITOR ENGINEERING NEWS:

On page 341 of ENGINEERING NEWS of July 17, 1886, you gave a method by which true prismoidal quantities can be taken direct from Crandall's *correction* table, without the use of tables for getting quantities by averaging end areas. Can you not give in an early number of your paper a *demonstration* of that method?

For convenient use of the method you suggest on heavy work Crandall's tables should be considerably extended. May we hope that a new edition may be soon issued adapted to that method.

Yours truly,

F. C. TUCKER.

[Let A and B be the areas in square feet of two sections 100 feet apart, and M the area of a section half way between A and B. By the prismoidal rule the content in cubic yards is

$$\frac{100}{6 \times 27}(A + 4M + B).$$

Now let c be the center cut at the first station, and w the distance between slope stakes, and let c' and w' be the same quantities for the second section. Let b be the width of roadbed, and d the half width of roadbed divided by the side slope ratio. Then we have

$$A = \tfrac{1}{2}(c + d)\,w - \tfrac{1}{2}\,b\,d$$
$$B = \tfrac{1}{2}(c' + d)\,w' - \tfrac{1}{2}\,b\,d$$
$$M = \tfrac{1}{2}\left(\frac{c + c' + 2d}{2}\right)\left(\frac{w + w'}{2}\right) - \tfrac{1}{2}\,b\,d.$$

By inserting these in the prismoidal rule the content is

$$\frac{100}{12 \times 27}\Big((2c + c')\,w + (c + 2c')\,w' + (w + w' - 2b)\,3d\Big)$$

which is the equivalent of three prismoidal corrections and corresponds with the method as stated. It should be mentioned, however, that the use of two tables instead of one will often facilitate the numerical computation, as the arguments are simpler and a part of the quantities taken out for one prismoid will also serve for the next.—ED. ENG NEWS.]

An Opportunity for Manufacturers

MARSHALL, TEXAS, October 12, 1886.

EDITOR ENGINEERING NEWS:

We now have our street rail road in course of construction, and will have four miles in operation in about three months. It will be built in a first-class manner, and everything that goes into its construction will be new and first-class. The New York Contract Co., which has the contract for putting in our gas plant, has everything in readiness, and will begin work about the 1st of November, and will put it in as fast as money and men can.

We have the best point in Texas for a first class spoke and hub factory, and any party who would come here for that purpose would meet with a hearty co-operation on the part of our people in establishing an enterprise of that character. We have abundance of good first-class timber to go into that kind of an establishment, and it can be had readily at a very small cost, say about $4 to $6 per cord for spoke and hub timber of oak, hickory and red elm, and there is plenty of red cedar in a convenient distance and plenty of railroad advantages, this being the eastern terminus of the Texas and Pacific Railway, and the western terminus of the New Orleans Railway, and also the beginning of the Marshall, Paris and Northwestern Railway. Our iron interest (undeveloped) is only second to Birmingham, Alabama.

We want manufactories. Can't you send us some?

Yours very truly,

JAMES H. CARTER, Mayor.

NEWS OF THE WEEK.

Contracting.

Davis Island Dam.—Contracts have been let for about $15,000 of improvement to complete the work. The work consists of earth filling, paving, and crib work. The bed of the river will be covered with rip-rap stone where there is no rock bottom.

City Contract Wages.—At Mankato, Minn., the city council has passed an ordinance providing for the payment by the city of laborers working under city contractors. The order was rendered necessary because in previous years several contractors have collected the money for wages and absconded with it.

Sewers.—At Philadelphia, Pa., the contract for the Wissahickon valley sewer has been awarded to James Deehan at $7 per lineal foot.

At Montreal, Canada, contracts for sewers have been awarded to Laurence Macdonald at $5.90 and $6.05 per yard and rock excavation $3 per lineal yard. Also to Felix Bracken: sewer $1 per yard; excavation, $1.75 per yard; man hole shafting $21 and lamp holes, $1.80.

Levee Work.—The following contracts have been awarded by the Louisiana State Board of Engineers: New Texas levee, Morgan O'Connell, 14¾ cents per cubic yard; Upper Ten levee, P. Harnan, twenty cents; Cofield levee, W. H. Davis, 14 cents; Cabanocey levee, P. J. Tyrell, 17½ cents; Gibsey levee and Louisa levee, John Cleary, 14¾ cents; Morganze levee, Peter J. Trezevant 25 cents.

A Large Compressor.—The Rand Drill Co., New York City, has shipped the fourth large duplex compressor to the Hydraulic Power Co. at Quinnesec Falls, Mich. The cylinders are 36 by 60 inches; those of the other three were 32 by 60 inches and they have been in use two years. They are worked by water from the falls; the main air pipe is 24 inches diameter and three

miles long: the air drives all the machinery of the Chapin and Ludington iron mines.

Dredging.—Savannah Harbor; John F. Gaynor; wing-dams and training walls, mattresses, 38 cents per square yard; stone, $3 per cubic yard; dredging, 19 cents per cubic yard. Brunswick Harbor: jetty work, E. H. Gaynor; mattresses, 55 cents; stone, $3; dredging, Savannah Dredging Co., 26 cents. Cumberland Sound: jetty work, A. M. Bangs; mattresses, 47 cents, stone, $2.89, Potomac river, at Baltimore; dredging and banking, Frank Somers, 10½ cents per cubic yard; repair work, G. Vanderwerten, 83 cents per cubic yard.

Paving.—At Baltimore, Ind., the following proposals have been received, for grading per cubic yard, curbing per lineal foot, and paving per square yard respectively: Owen Patterson, 20, 40 and 5.5 cents; Morgan & Bressman, 25, 40 and 5.5 cents; Thomas F. Locke, 30, 40 and 6 cents; W. J. Flannery, 14, 45 and 4½ cents; A. J. Holbrook, 30, 50, and 6.5 cents; J. P. McGovern, 22.5, 42 and 5.5 cents; E. Heffner, Jr., 22, 40 and 6 cents; Conway & Bates, 28, 40 and 5.75 cents; W. R. Weaver & Co., 17, 38 and 5 cents; P. Reddington, 24, 40 and 5.25 cents; J. E. Lyons, 17, 37 and 4.9 cents.

Crib and Rip-Rap.—The following are the prices bid for cribs and rip-rapping at Battery island, Chesapeake bay; the bidders were P. G. Bailey, New York City; the Frank Pidgeon Dredging Co., New York City; Duncan A. Gillies, Baltimore, Md.; W. B. Brooks, Jr., Baltimore, Md.; John E. Lyons, Baltimore, Md., and the prices are given in their order: Georgia pine, per 1.000 feet B. M., $49, $60, $32, $32.50, $34; white oak (either one of these timbers to be used), $74, $90, $35, no bids; locust tree-nails, per 100, $5, $5, $3, $3.50, $5; stone filling, per perch, $2.94, no bid, $2.87, $2.60, $2.49; stone rip rap per perch, $2.94; no bids $2.75, $2.60, $2.49; spikes, bolts, etc., per pound, 6 cents, 6 cents, 2½ cents, 4 cents, 6 cents. All bids were rejected as being too high.

Railroads, Bridges and Canals.

Accident on the New Croton Aqueduct.—On Tuesday last as six men were ascending in the cage at Shaft 27, (Tenth avenue and 176th street) the rope broke letting the cage fall to the bottom, One man was killed and three seriously injured.

Mississippi River Improvement.—Major Charles Allen has been directed to proceed with the survey of the river between St. Paul and Minneapolis and prepare an estimate of the cost of preparing it for navigation.

The Poughkeepsie Bridge.—The masonry of pier No. 2 will be taken out shortly and a larger pier built, the crib and caisson are in perfect condition; pier No. 3 will be sunk 25 feet deeper. The crib for pier No. 4 is being built and that for No. 5 will be commenced soon. Work is in progress on Piers Nos. 1 (west shore) and 6, and on the east and west anchorage piers. The masonry contractors, Messrs. Dawson, Symmes & Usher, are getting their machinery on the ground, including some engines built for the construction of the Niagara cantilever bridge. Arrangements have been made with the West Shore R. R. regarding the blasting near the line, work has been commenced. A large number of Italian laborers have arrived and others will be sent on. Constructing Engineer O'Rourke states that except for a few days when running ice may interfere, the work of construction will be pushed right along during the winter. P. W. Gallaudet, of New York, has been elected Treasurer of the company. A contract has been signed for the construction of the Poughkeepsie & Southwestern R. R., from the western end of the bridge to the New Jersey state line; the engineers are now locating the line, and construction will be commenced this season.

The Detroit Tunnel is again to the fore. Two companies, one in the United States and the other in Canada, are said to have been organized with $1,000,000 capital each, to run a tunnel under the St. Clair river at Port Huron. This tunnel will be one mile long, 2,300 feet under the river, 1,100 underground in Canada, and 1,800 feet underground in the United States. The total cost is estimated at $1,500,000 and work will be commenced "at once." As published, Joseph Hobson is the President of the Consolidated Co. and Joseph Hobson is Chief Engineer.

Notes of Foreign Railroads.—Four new lines are projected in Sicily: from Syracuse to the Ragusa-Vizzina R. R.; from Caltagirone to the Syracuse-Vizzina R. R., with a junction between Terranova and Biscari; from Vittoria to Scoglitti, and from Ragusa to Vizzina: the aggregate length is 87 miles and the cost will be $6,250,000.—The New South Wales House of Assembly has approved plans for nine railroads; the line to Tenterfield, near the Queensland border, is to be opened this month: when the line on the Queensland side of the border is completed there will be communication between Adelaide, Melbourne, Sydney and Brisbane.—The Cape Government has decided to admit mining, railroad and other plant for all parts of South Africa free of duty and will forward the same at special rates by railroad to Kimberly, the nearest accessible point to the interior.

CONTRACTORS INTELLIGENCE.

Engineering and Building Materials.

WHOLESALE PRICES.

Chicago, Oct., 21, 1886.

IRON.

Quotations given by Jones & Laughlins, Limited.

STRUCTURAL IRON.			
Angles	2.30	@	2.40
" Steel	2.40	@	2.50
Tees			.2¾c.
Beams, channels, American			.3½c.
Tank plates			2.40
Shell plates	3.00	@	.3¼c.
Steel plates, Tank			.3c.
Quotations by Fieldhouse, Dutcher & Belden.			
WROUGHT-IRON PIPE.			
Butt welded, black.....Discount			.42½
" " galvanized... "			.32½
Lap " black... "			.55
" " galvanized... "			.37½
Quotation by National Tube Co.			
Boiler Tubes			.50
Quotations by North Chicago Rolling Mills Co.			
RAILS.			
Steel	$37.00	@	$38.00
Old Rails—Iron	21.00	@	22.00
Quotation by Garnegie Brothers & Co., Limited			
"—Steel	20.00	@	21.00
Quotations given by Jones & Laughlins, Limited.			
R. R. spikes			2 40
R. R. splice-plates	1.90	@	2.00
R. R. track bolts, square nuts			.3c.
Quotations given by Washburn & Moen, Manfg. Co.			
Barb wire fencing, galvanized			.4c.
" " painted			.3¾
Quotations given by H. C. Green & Co.			
CORRUGATED IRON-SHEET.			
Wire gauge.....16 to 20		24	26
Black, per lb	3½	3½	3½
Galvanized per lb	6	9¾	
Nos. 28		6¼	6½
NAILS.			
Iron, per keg	2.10		
Steel, " "	2.20	@	2.25

METALS.

COPPER.			
Lake Superior			10.25
LEAD.			
Pig, Domestic	4.75	@	4.80
Lead Pipe	.06¼c	@	.06¾
Tin-Lined Lead Pipe	.15		
Sheet Lead	.07¼		
ZINC.			
Sheet	5.65		

BRICK.

Quotations given by Lockwood & Kimball.

Common.....per M	8.00	@	8.50
PRESSED.			
Chicago, Anderson	18 00	@	27.00
Indiana	16.00	@	22.00
Perth Amboy, Buff			50.00
" Mottled			50.00
Tiffany	6.00	@	27.00
St. Louis			27.00
Trenton	40.00		
Philadelphia			50.00
Baltimore			55 00
Milwaukee			25 00
Zanesville			30.00
" Enamelled			30.00
Toledo Red, common			12.00
" " stock			17.00
Fire Brick	25.00	@	30 00

LIME, ETC.

	Per Cask.		
Chicago Lime	90.	@	1.00
Wisconsin "	.90	@	1.00
Hair—cattle, per bu	.20	@	.25
"—goat, "			.40
Sand, Lake shore, per yd	1.00	@	1.25
Plaster of Paris	1.75	@	2.00

CEMENT.

Portland	3.00	@	3.50
Milwaukee, Utica, Louisville, Akron			1 25
Keene's Coarse	7.50	@	9.00
" Fine	11.00	@	12.00

STONE.

Quotations given by Chicago Stone Building Co.

	Per cubic foot.		
LIMESTONE. Promiscuous blocks, f. o. b. cars; Chicago.			
Blue Bedford			.65
Buff			.50
Joliet	.35	@	.50
Lemont	.40	@	.50
FOUNDATION.			
Dimension, on dock	8.00	@	8.25
Rubble, per perch	.20	@	.25
Sidewalks, laid, 8" to 12" } sq. ft.	.65	@	.75
" 6" to 8" }			
Planed	.40	@	1.00
SAND-STONE. Promiscuous blocks.			
Amherst	.60	@	.75
Berea	.55	@	.65
Philadelphia brown stone			1.50
Connecticut " "			1.50
Carbondale			1.10
Malone Blue Euclid	.55	@	.65
New York Bluestone	.35	@	1.40

MARBLE.

Quotations given by Georgia Marble Co.			
Cherokee, and Creole			1.60
Ellowah			2.10
Quotations given by Davidson & Sons.			
Rutland	3.00	@	9.00
Concord			5.25
Sutherland Falls	2.50	@	5.50
St. Lawrence			5.00
East Dorset Italian	2.50	@	4.50
Mountain Park	2.25	@	6.00
Vermont			3.00
Tennessee, Red	7.00	@	9.00
" Concord	2.50	@	5.00
Italian, Veined			4.90

SLATE.

Quotations given by Edward Johnson, 14 and 16 East Van Buren street.

Green Roofing, per square			5.20
Purple " "			6.00
Red " "			12.50
Black Lehigh " "	5.25	@	5.50
" Bangor " "	5.50	@	5.80

LUMBER, Car Lots.

	Per M.		
THICK CLEARS AND SELECTS.			
Mixed Lengths, Dry.....Rough	20.00	@	47.00
ONE INCH FINISHING.			
Mixed Lengths, Dry.....Rough	24.00	@	47.00
12-INCH STOCK BOARDS.			
D to A	23.00	@	42.00
Common Stock Boards	11.50	@	16 00
BOX BOARDS, D to A	22.00	@	24.00
FLOORING STRIPS, ROUGH, 6 INCH.			
1st and 2nd clear			39.00
A Siding Strips			39.00
C and A Flooring "	22.00	@	30.00
FLOORING DRESSED AND MATCHED.			
D to A, 6-inch	17.60	@	31.00
No. 1 Fencing	13.00	@	18.00
Norway, clear, C to A	17.00	@	22.00
8 and 10 inch No. 1 Boards, D and M	14.50	@	15.00
C to A Partition D and M, 2 sides, 4 beads	27.00	@	39.50
Beaded C and K ing, Tied	14.50	@	32.00
Common and Cull Boards, Dry	11.00	@	13.00
Common and Cull. Fencing	11.50	@	13.50
BATTENS.			
O. Gt. or Beveled per 100 lin. ft.	.50	@	.70
TIMBER, JOISTS AND SCANTLING.			
All 2x4, 12 to 24 ft	$12.00	@	$13.50
" 2x6, "	12.00	@	16 00
" 2x8, "	12.00	@	14.50
" 2x10, "	12.00	@	16.00
" 2x12, "	12.00	@	17.00
4x4 to 8x8 "	12.00	@	15.00
2 inch cull. plank, prom' width			9.00
2x4 " 14 and 16 ft			10.00
BOARDS, ordinary dimensions.			
Pine, 1st quality clear	$46.00	@	$48.00
" 2nd " "	44.00	@	47.00
" 3rd " "	42.00	@	44.00
Common			13.00
SIDING.			
Pine	10.00	@	21.00
FRAMING TIMBER, Pine	14.00	@	17.00
Laths "			1.75
Shingles " sawed	2.10	@	2.40
" cedar	2.00	@	2.20
Pickets, pine	9 00	@	19.00
Posts, cedar	9.00	@	21.00
Pine, yellow southern	28.00	@	35.00
PINE, YELLOW GEORGIA,			
1st and 2nd clear, 4 inch flooring			35.00
" " " 6-inch "			35.00
Boards	33.00	@	35.00

HARDWOODS

Ash, 1st and 2nd, 1 inch	23.00	@	25.00
Maple, " " " " "	20.00	@	21.00
Walnut " " " " "	100.00	@	175.00
Oak White, 1st and 2nd, 1 inch	16.00	@	38.00
" Red " " " "	22.00	@	24.00
Cherry " " " " "	65.00	@	85.00
Beech, Red " " " "	25.00	@	30.00
Whitewood " " " "	22.00	@	28.00
Birch, Red, 1st and 2nd, 1 inch	23.00	@	25.00
Butternut " " " "	30.00	@	40.00
Sycamore " " " "	22.00	@	25.0
Gum " " " "	20.00	@	23.00
Basswood " " " "			20.00
Hickory " " " "	26.00	@	30.00
Elm " " " "	14.00	@	16.00
Chestnut " " " "	32.00	@	37.00
Rosewood, per lb	3c.	@	15c.
Mahogany, Mexican, per ft	.15c.	@	.20c.
" St. Domingo, per ft	.20c.	@	.25c.
" Cuba, per ft	.12c.	@	.20c.
California Redwood Lumber	42 50	@	44 50
" Shingles	4.60	@	4.90
" Pine	65.00	@	75.00
Mexican Spanish Cedar	150.00	@	300.00
Georgia Cypress Lumber, 1st and 2nd clear	35.00	@	40.00
Georgia Cypress Shingles	3.75	@	4.25
CALIFORNIA OAK.			
Plank	23.00	@	25.00
Timber	24.00	@	30.00

PAINTS.

	Dry.		In Oil.
	7		7½
Lead, White (American) Dry	8, 10, 10	@	13
Zinc "			13
Red Venetian	2.6		12
Vermillion		2 @	75
India Red		15 @	20
Yellow Ochre		6 @	10
" Chrome	12 @	20 12 @	20
Green "	12 @	15 10 @	16
Black, Lamp	8 @	25 10 @	15
Putty	Bulk	.2 Bladders	.3
Blue, Ultramarine		.16	.35
Whiting, dry		.1	
Litharge—American		.7	
Sienna, burnt		.9	.15
Umber, burnt		.7	.16
Oil, Linseed (raw) per gal		.44	
" " (boiled) "		.47	
Turpentine "		.38	
Varnish, coach		1.25 @	2.00
" shellac		3.25 @	4.00

ASPHALT.

BARBER ASPHALT.			
Pavements Laid:			
Without foundation, per sq. yd			2.00
With " " "			3.00
Asphalt Blocks:			
Macadam foundation, per sq. yd	2.81	@	2.97
Without macadam foundation, per sq yd			2.75

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials.

WHOLESALE PRICES.

New York, October 21, 1886.

IRON.

STRUCTURAL IRON.		
Angles	2.15c	@ 2.30c
" steel	2.40	@ 2.50
Tees	2.50	@ 2.60
Beams and channels, American	3.00	@
Tank plates	2.25	@ 2.35
Shell plates	2.50	@ 2.60
Steel plates, Tank	2.70	@ 2.75
WROUGHT-IRON PIPE, PITTSBURG.		
Butt welded, black Discount		42½
" galvanized "		32½
Lap welded, black "		55
" galvanized "		37½
Boiler tubes "		47½
RAILS.		
Steel (large lots at mill)	$34.00	@ $35.00
Old rails	21.00	@ 21.50
Old rails, steel	22.00	@ 23.00
R R. spikes	2.15c	@ 2.20c
R R, splice-plates	1.70	@ 1.90
R R. track bolts, square nuts	2.50	@ 2.75
Barb-wire fencing, galvanized	3.85	@ 3.90
" painted		4.00
Corrugated iron		
Nails		
Iron, per keg	2.00	@ 2.10
Steel do.	2.10	@ 2.20

METALS.

COPPER.		
Lake Superior	11.12	
Other Brands	11.05	@ 11.45
LEAD.		
Com. Domestic	4.30	@ 4.35
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.60	@ 5.70

BRICK.

Cargoes (afloat)		
Choice Brands	8.50	@ 9.00
Haverstraw per M.	7.25	@ 8.00
Fishkill	7.50	@ 7.25
Up-River	7.50	@ 7.00
Jerseys	6.25	@ 7.00
Long Island		
Pale	4.75	@ 5.00
FRONTS.		
Croton, red	13.00	@ 15.00
" dark	13.00	@ 15.00
" brown	12.00	@ 14.00
Philadelphia pressed	27.00	@ 28.00
Trenton "	25.00	@ 26.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	90.00	@ 120.00
Fire brick	25.00	@ 55.00
" American, No. 1	30.00	@ 35.00
" " No. 2	25.00	@ 30.00

ASPHALT.

ROCK.		
French, per ton	$20.00	@ 25.00
German	15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.05
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " "		
Brown stone, Portland, Ct. "	1.00	@ 1.35
" Belleville, N. J. "	0.75	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
se stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00
oncrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@ 20.00
Choice "	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44	@ .50
Tally boards, dressed com. "	.28	@ .30
SPRUCE, Boards dressed "	.25	@ .28
Plank, 1¼ in "	.28	@ .30
" 2 in. "	.38	@ .40
" 2 in. dressed "	.43	@ .45
Timber per M.	14.00	@ 18.00
HEMLOCK, Boards each.	.18	@ .20
Joist, 2½ × 4 to 4 × 6 in	.16	@ .44
OAK per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00	@ 40.00
YELLOW PINE, Girders "	25.00	@ 30.00
Dressed flooring "	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75	@ 6.00
LATH, Cargo rate "	2.30	@ 2.40

PAINT.

Lead, white, American dry per lb	.04¾	@ .06¼
" " " in oil pure "	.07	@ .07½
" English, B. B. in oil "	.08¼	@ .08¾
" Red, American "	.06½	@ .07
Litharge "	.05½	@ .06
Venetian red, American "	.01	@ .01¼
Indian red "	.08	@ .10
Vermillion, American lead "	.10½	@ .11½
Paris green "	.15	@ .18
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer. "	.07	@ .13
" Eng. "	.11	@ .13
Chrome green "	.10	@ .25
Oxide zinc, American "	.03½	@ .03½
" French "	.05½	@ .07½

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Port.and	$2.60	@ $2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25	@ 2.50
Fewen	2.25	@ 2.50
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40	@ 2.75
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50	@ 2.75
K. B. & S. " "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
EMIL LENZ, New York.		
Stettin Portland	2.35	@ 2.55
Fire-proof	1.75	@ 1.95
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BABSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S.	2.25	@ 2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25	@ 2.40
German "	2.00	@ 2.15
Standard	1.50	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand,	1.00	@ 1.10

MARKET SUMMARY.

Brick are in quick demand at prices again advanced. We quote extra quality Haverstraws $8.50@$9.00 per M. Firsts $7.75@$8.00. Seconds $7.25@7.50. Fishkills sell readily at $7.25@$7.50 and other Up Rivers at $7.00@$7.80. Pales have also advanced and fetch $4.75@$5.00 per M; Philadelphia and Wilmington fronts are worth $28 per M. Crotons are unchanged. Rosendale cement is now firmly held at $1.10 per barrel; the market being cleared of inferior brands, this is the lowest quotation for full lots. Portland cement has arrived very freely the past few days, and importers have had to look round for customers, sales are reported at $2.15@$2.25 per barrel at ships tackles, with some brands as low as $2.05 of good quality, but not well known manufacture. Lime is in fair demand at regular quotations, with arrivals amply sufficient for dealers necessities. The Lumber Market is about as last week. Lath is still actively inquired for, and we hear of sales of 3,000,000 at $2.35 per M. to arrive, with some parcels sold at $2.30 and $2.40 asked in some instances. Spruce dimensions $14 to $18 according to schedules. Yellow Pine $18 to $21. Plaster and Hair are unchanged with a seasonable demand. Paints and Oils show little variation in quotations. Turpentine is fetching 37c. per gallon, and Linseed Oil is attainable at 41c. per gallon, 44c. boiled. Lead is still unsettled, and buyers scarce, $4.25c. is about the quotation, with sales rumored at a fraction less. Pig tin is again lower, and sales have been made at 22@22.10c. Tin plate is firmer with a good demand for future deliveries, spot quotations are as follows: I. C. charcoal, ½ cross assortment, $4.60@$4.65 for Allaway, and $5.15@$5.20 for Melyn grade; for each additional X add $1 and $1.50 respectively. I. C. coke, $4.25@$4.30 for B. V. grade; $4.32½@$4.35 for J. B. grade. I. C. Bessemer steel, $4.32½@$4.35. Charcoal terne, $4.15@$4.17½ for Allaway grade; $4.20@$4.22½ for Dean grade, 14x20, and $3.30 and $3.45 respectively for do, 20x28.

The Hardware Market is in a fairly healthy condition, but prices are hardly up to the standard, and manufacturers, especially of nails, hope to see a way to obtain an upward movement to compensate for the increased cost of material. Nails are still quoted at $2.00@$2.10 per keg for 10d. to 60d. for store lots.

BUILDING ITEMS.

Mr. Geo. A. Freeman, Jr., reports plans on the boards for six brick, stone and terra-cotta residences, to be built on a lot 100x100 by Mr. Peters, at a cost of about $60,000, on West Eighty-third street, also for a stone and frame stable, to be built at a cost of $20 000, at Riverdale, for Mr. Goodrich.

Mr. Lawrence J. O'Connor has just completed plans and awarded the contracts for a brick basement and frame building, to be built in connection with St. Mary's church, Bergen Point, at a cost of $10,000.

Mr. Chas. E. Miller, 149 Broadway, has on the boards plans for a $4,000 cottage to be built at Buzzards Bay, Mass., for Mr. Jas Powers.

Messrs. Geo. E. Harding & Dinkleburg report plans now being prepared for a handsome Indiana limestone villa, to be erected on Bellevue avenue, Newport, at a cost of $40,000.

Mr. James Stroud, has on the boards sketches for a house 30x130 for summer boarders, which Mr. J. Lowery proposes to build at Bath, L. I., at a cost of $15,000.

Messrs. A. B. Ogden & Son have designed a six-story and basement, brick and stone store 28x76.3, to be built for Lawrence Kelly on the northwest corner of Spring and Mulberry streets, at a cost of $28,000.

Messrs. Wm. Shickel & Co. are the architects for the model tenements, mentioned in these columns last week, as to be erected by the Tenement House Building Co. on Cherry near Montgomery street, they have also prepared plans for a three story brick stable, 27.6x84, to be built for the Sisters of Charity of St. Vincent de Paul on the north side of Sixty-seventh street between Second and Third avenues, at a cost of $12,000, also for similar building to be built adjoining it for Park Commissioner Crimmins.

Mr. Jas. Brown Lord has prepared plans for seven four-story brick dwellings, 21.4 and 21.8x53, to be built for Mr. Chas. T Barney, on the north side of Seventy-fourth street, 100 feet east o Tenth avenue, at a cost of about $80,000.

Mr. Lansing C. Holden, No. 2 West Fourteenth street, has completed plans for a five-story brick and stone warehouse, 60x100, to be built at a cost of $50,000 at Binghamton, N. Y.

Mr. Jas. E. Ware, is architect for alterations to be made at a cost of $10,000 to Nos. 198 to 202 Forsyth street, for Messrs. Halstead & Co.

Mr. E. D. Lindsey has prepared plans for four three story and basement brick dwellings, 14x48 each, to be built on Warburton avenue, Yonkers, at a cost of $20,000.

Mr. G. Robinson, Jr., is perfecting plans for a five-story brick and stone flat, which he proposes to erect on the west side of Second avenue, 50 feet north of 118th street, at a cost of about $25,000.

Messrs. Chas. Graham & Sons will erect from their own designs on Madison avenue, between Seventy-ninth and Eightieth streets, sixteen first-class private residences.

Mr. John C. Burne has on hand plans for four five-story brick stone and terra-cotta flats, with stores, to be built for Mr. W. Terriberry on the southwest corner of Eighth avenue and 137th street, at a cost of $79,000.

Mr. Oscar S. Teale is the architect for a hotel to be built at Paducah, Ky., at a cost of $75,000.

Mr. Robert Mook has on hand designs for alterations to be made at a cost of $7,000, to the building on the northwest corner of First avenue and Twenty-fifth street, of which Mr. A. T. Kruse is owner.

The New York Real Estate and Building Improvement Company has been incorporated by Wallace C. Andrews, George E. Harney, Ferdinand Fish, Frederick M. Littlefield, George W. Lithgow, Thomas Dimond, and Joseph C. Davis. Its capital stock is $100,000, and its purposes are to own and improve real estate.

TRADE NOTES.

THE SHEFFIELD VELOCIPEDE CAR CO. forwards us a very artistically conceived catalogue, describing the various railway specialties manufactured by them at Three Rivers, Michigan. The chief point of interest in this catalogue centers about the various forms of velocipede cars, to be run by one, two or three men. The "one-man" car has been found so useful in the supervision of track, telegraph repairs, for use by road-masters, bridge-foremen, tie-inspectors, etc., that this company has made its construction a special feature, and in this catalogue illustrates very handsomely its various forms and uses.

NEWARK, N. J.—The Aqueduct Board has received three propositions for a water supply. (1) From D. H. Tichenor, representing a syndicate; the proposition was to furnish 15,000,000 gallons daily from artesian wells at Belleville to be connected with the city's pumps; estimated cost, $150,000. (2) Grom the National Water Purifying Co., to supply 15,000,000 gallons per day, with six patent filters; the company is composed of Charles P. Worthington, Theo. F. Miller and W. M Deutsch: estimated cost, $180,000. (3) From Robert Crane, of Philadelphia; the water would be elevated and made to pass through a patent filter; estimated cost, $10,000.

New Croton Aqueduct.—The tunnels from Shaft 0 and Shaft 1 met October 14, after two years work: No. 0 is at the Croton lake and the distance is 4,857 feet, of which the men from No. 0 drove 3,335 feet and those from No. 1 1,522 feet. At 11 P. M. only 8 feet of rock intervened, which was soon pierced both ways by the 12-feet drills, and the hole was broken through with dynamite.